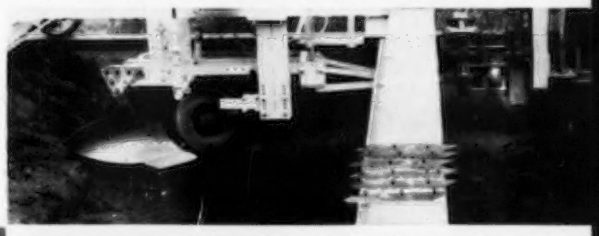
JUNE 1958

Agricultural Engineering

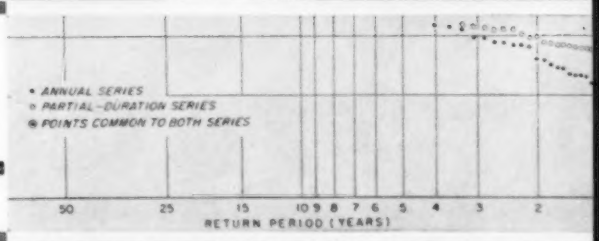
The Journal of the American Society of Agricultural Engineers

Soil Reaction To Plow Share Design | 336

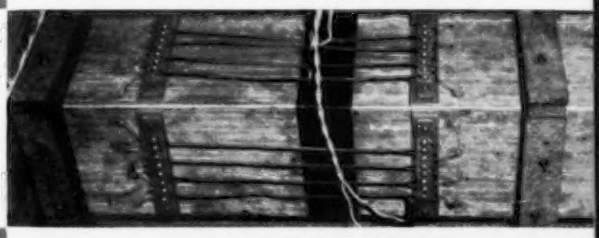


Soil Reaction to Subsoiling Equipment | 340

Frequency Analysis of Rainfall Intensity Data | 344



Lateral Duct Air Flow Patterns | 348



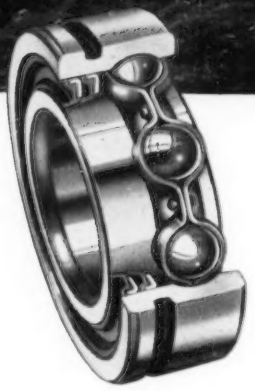
Mechanical Swine Exerciser | 352

FACTS

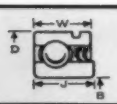
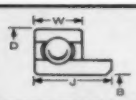
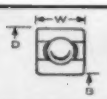
LUBRICATED-FOR-LIFE DISC BEARINGS CUT MAINTENANCE ON PLOWS

Disc plows mounted with New Departure integrally sealed, factory-lubricated ball bearings require NO field servicing. In fact, no grease fitting is provided or even needed. With New Departure ball bearings, discs turn freely, wear evenly and longer. They remain fully adjusted . . . assuring no unplowed furrows. And . . . with field adjustment eliminated, there's never a danger of bearing contamination.

Photo: Courtesy of J. I. Case Co.

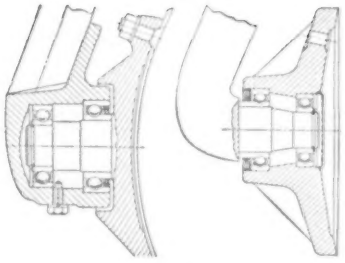


DIMENSIONS

TYPE I  TYPE II  TYPE III 

Plow Size*	Position	Bearing Number	Type	Bore B	Diameter D	Width W	Width J
24 RS	Front	905422	I	1.6250	3.2677	1.014	1.024
24 RS	Rear	3207	III	1.3780	2.8346	.669	—
24 SS	Front	3208	III	1.5748	3.1496	.709	—
24 SS	Rear	905422	I	1.6250	3.2677	1.014	1.024
28 RS	Front	4510 A	II	1.9685	3.5433	.787	1.297
28 RS	Rear	3208	III	1.5748	3.1496	.709	—
28 SS	Front	3208	III	1.5748	3.1496	.709	—
28 SS	Rear	4510 A	II	1.9685	3.5433	.787	1.297
32 RS	Front	3L13	III	2.5591	3.9370	.709	—
32 RS	Rear	3210	III	1.9685	3.5433	.787	—
32 SS	Front	3210	III	1.9685	3.5433	.787	—
32 SS	Rear	3L14	III	2.7559	4.3307	.787	—

*RS indicates rotating spindle; SS indicates stationary spindle



Rotating spindle disc plow mounting featuring a two lip integral seal bearing.

Stationary spindle disc plow mounting featuring extended inner race for mounting external seal.

SEND FOR CATALOG FIC-B

NEW DEPARTURE

1908–1958 GM FORWARD FROM FIFTY

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

(For more facts circle No. 56 on reply card)

NOW... more manufacturers can afford to put more ball bearing efficiency to work in more places

Aetna

ADAPTER BEARING

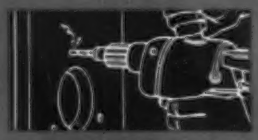
Economical to buy . . . economical to apply

Equipment manufacturers who must stretch bearing dollars in order to build to a price need look no further than this Aetna Adapter bearing —the completely *PACKAGED* ball bearing unit that brings low-cost, anti-friction efficiency within the range of all light-duty slow-speed equipment.

Designed and built-to-be-installed-and-forgotten, this permanently lubricated, sealed-for-life Adapter bearing requires no re-lubrication, no maintenance of any kind. It combines self-aligning bearing, seals, mounting flange and locking collar in a single, compact, factory-assembled *PACKAGE* that mounts easily, quickly, wherever shafts can be supported, including mounting on sheet metal or any semi-rigid structural member. Available in 8 standard shaft sizes, ½" to 1¼". Send for catalog AG-57 or call in the local Aetna representative listed in the yellow pages. Aetna Ball & Roller Bearing Co., Division of Parkersburg-Aetna Corp., 4600 Schubert Ave., Chicago 39, Ill.

EASY, QUICK 3-STEP MOUNTING

1



Drill (or punch) 3 bolt holes in shaft supporting member.

2

Place Adapter bearing in position, insert bolts and tighten nuts.

3

Install shaft, twist locking collar, tighten set screw.

Aetna ANTI-FRICTION CONSULTANT TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

Agricultural Engineering

Established 1920

CONTENTS • JUNE, 1958 • Vol. 39, No. 6

Report to Readers 325

Editorial 335

Soil Reaction to Plow Share Design 336
M. L. Nichols, I. F. Reed and C. A. Reaves

Soil Reaction to Subsoiling Equipment 340
M. L. Nichols and C. A. Reaves

Frequency Analysis of Rainfall Intensity Data 344
W. T. Wilson and D. M. Hershfield

Lateral Duct Air Flow Patterns in Grain Drying Bins . . 348
D. B. Brooker

Mechanical Swine Exerciser 352
M. F. Finner, E. J. Briskey, R. W. Bray, W. G. Hoekstra and R. H. Grummer

Technical Paper Abstracts 354

Readers' Forum 355

News Section 356

Manufacturers' Literature 361

New Products 364

Research Notes 370

Index to Advertisers 376

Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 North First Street, Ann Arbor, Michigan.

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

JAMES BASSELMAN, *Editor and Publisher*

OFFICERS AND COUNCIL

American Society of Agricultural Engineers

EARL D. ANDERSON, *President*

Vice-Presidents	*Councilors*	*Past-Presidents*
W. J. Ridout, Jr.	G. E. Henderson	Roy Bainer
Lloyd W. Hurlbut	David C. Sprague	Wayne H. Worthington
Henry J. Barre	George M. Eveleth	

JIMMY L. BUTT, *Executive Secretary*

RALPH A. PALMER, *Treasurer and Assistant Secretary*

RAYMOND OLNEY, *Counselor*

Central Office: 420 Main Street, St. Joseph, Michigan

SUBSCRIPTION PRICE: $5.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 50 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

The American Society of Agricultural Engineers is not responsible for statements and opinions advanced in its meetings or printed in its publications; they represent the views of the individuals to whom they are credited and are not binding on the society as a whole.

TITLE: The title AGRICULTURAL ENGINEERING is registered in the United States Patent Office.

COPYRIGHT: Copyright, 1958, by the American Society of Agricultural Engineers.

Reprints may be made from this publication on condition that full credit be given AGRICULTURAL ENGINEERING and the author, and that date of publication be stated.

AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.

ASAE Section Honors J. E. Nicholas

Professor and Mrs. John E. Nicholas listen as Oscar C. Lange reads citation on a plaque presented by the Pennsylvania Section of ASAE in honor of Professor Nicholas' 29 years of teaching and research at Pennsylvania State University

THE Pennsylvania Section of ASAE, during its annual banquet program, April 24, honored John E. Nicholas, professor of agricultural engineering, Pennsylvania State University, who will retire July 1 after 29 years of teaching and research. In tribute a plaque with the inscription, "For his devotion and contribution to the profession of agricultural engineering as an educator and research worker. His pioneering spirit in milk and egg cooling, food freezing, and radiation has fostered great changes in agriculture," was presented to the agricultural engineering department of Pennsylvania State University by the Pennsylvania Section. Formal presentation was made by Oscar C. Lange, former student of Professor Nicholas.

Gifts of binoculars and luggage were presented by F. W. Peikert, head, agricultural engineering department, on behalf of the faculty. R. P. Gehman of the student branch of ASAE presented two photographs of Professor Nicholas, one for the agricultural library and one for agricultural engineering building. A gift of a pewter pitcher was given to Mrs. Nicholas by Mrs. Ralph Patterson on behalf of faculty wives.

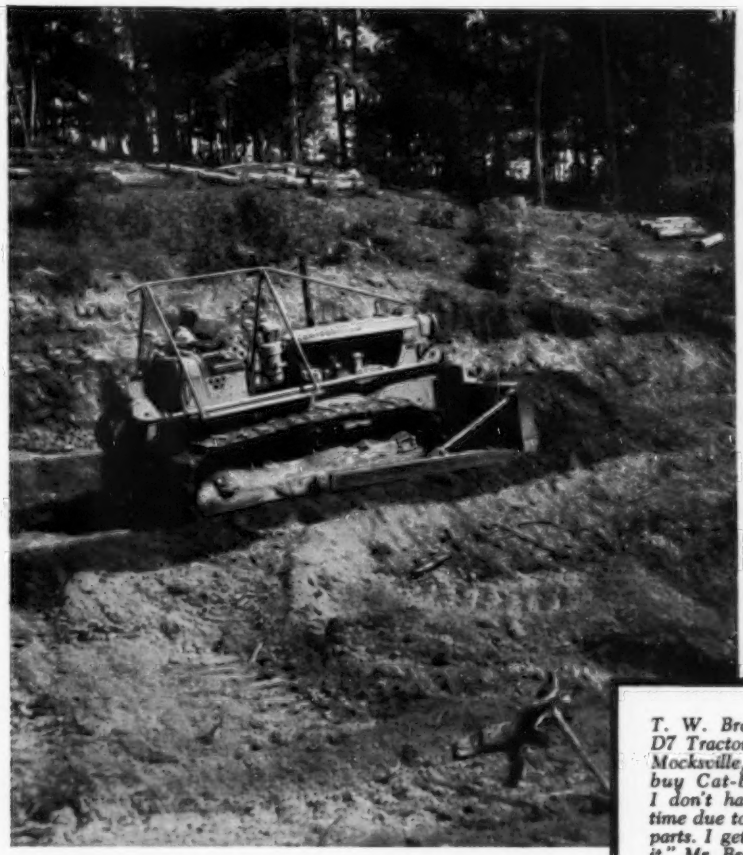
A book of letters of congratulations from friends, entitled "A Tribute to John E. Nicholas," was presented by H. V. Walton, associate professor of agricultural engineering. Alumni in agricultural engineering honored him with a Colonial style desk which was presented by K. H. Norris of the U.S. Department of Agriculture, also one of Professor Nicholas' former students.

Professor Nicholas was cited as being among the first to recognize the possibilities of mechanical refrigeration for milk on the farm. His study and analysis of milk cooling in cans received wide acceptance and resulted in continuing design changes. Milk cooling cabinets became standard dairy farm equipment following his research. More recently he has directed his attention to bulk milk tanks.

He was also cited for basic research in food freezing and storage. His findings were described as "leading to continued emphasis on the importance of rapid freezing, low holding temperatures, and economy in the use of electrical energy."

"Your work with continuous operation of the refrigerating unit on home freezers points the way to economical attainment of lower, more uniform storage temperatures," stated Burton S. Horne, associate professor of agricultural engineering extension, who gave an illustrated talk on Professor Nicholas' career.

Professor Nicholas received a B.S. degree in mechanical engineering from Lehigh University in 1915 and an M.S. degree in mechanical engineering from the Massachusetts Institute of Technology in 1926. From 1926 to 1929 he taught thermodynamics at the University of Minnesota and had charge of the mechanical engineering laboratory. In 1929 he came to Penn State. He currently is chairman of the ASAE Committee on Radiation and a former vice-chairman of the North Atlantic Section. He is a fellow of ASAE and the American Society of Refrigeration Engineering.



Here's the tractor that will make you and another man a good living!

T. W. Brown, owner of the CAT D7 Tractor shown here working near Mocksville, North Carolina, says, "I buy Cat-built equipment because I don't have to worry about down-time due to breakdowns or waiting for parts. I get good service when I need it." Mr. Brown also owns another D7, D6 and a No. 12 Motor Grader.

A message to the man who now owns one tractor, but wants to grow: Demand for the services of farm power contractor work is increasing. Perhaps you had to turn down customers last fall because you couldn't get to them. Maybe there's some turnpike or watershed work in your territory that you'd like to get. Perhaps you've thought of adding another machine, but decided against it because of the problem of getting a dependable operator, plus the care and headaches of keeping two tractors working.

If this is all that's holding you back, listen: Make that new tractor a Caterpillar Diesel Tractor, and you can cross a lot of your worries off the list! Right away your Caterpillar Dealer gets you off to a good start. His men know your type of work and will recommend exactly the right machine with proper equipment for your jobs. Then they check over your machine before and after delivery to be sure it is performing at 100% of its efficiency. They'll help you familiarize yourself and your operator with everything about the tractor . . . even help train your men. Then you can get set for thousands of hours of trouble-free service. You can practically bank on going 10,000 hours before overhaul. You can rely on your Caterpillar Dealer to be on hand with original Cat parts and service when and where you need them. You can take your equipment anywhere in the world, if you wish, and still know that nearby there's a Caterpillar Dealer ready, willing and able to serve you.

CATERPILLAR TRACTOR CO., Peoria, Ill., U. S. A.

FREE BOOKLETS FOR YOUR CUSTOMERS:
We'll gladly supply you with a quantity of our newest booklet, "Community Watersheds," to help you generate interest in watersheds among your customers and leaders in your area. Write us, telling how many you need. Address: Caterpillar Tractor Co., Dept. AE68, Peoria, Ill., U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

LAND DEVELOPMENT PARTNERS:
CONSERVATIONISTS • FARM POWER CONTRACTORS
YOUR CATERPILLAR DEALER

(For more facts circle No. 60 on reply card)

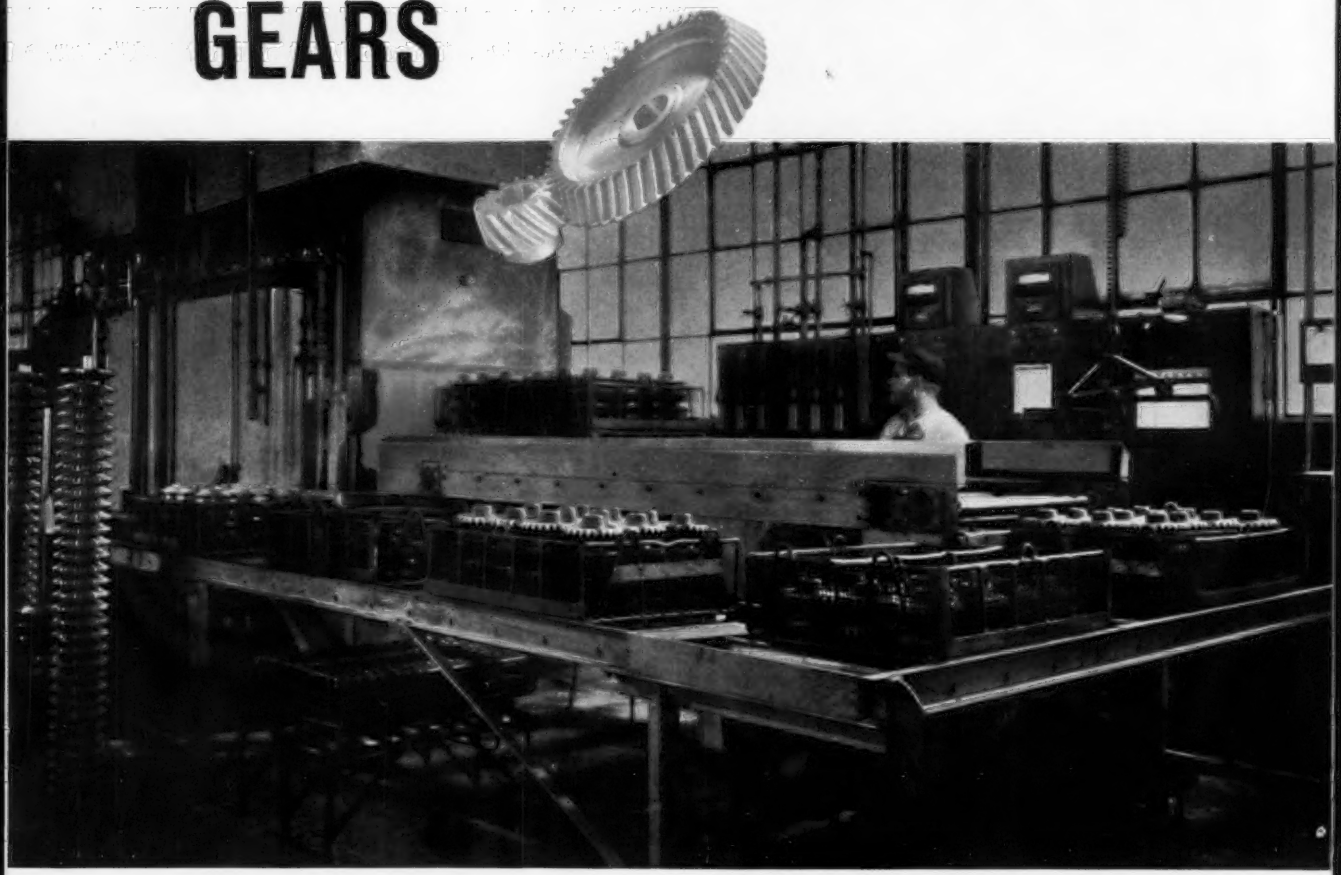
Friendly inferno— to make BETTER GEARS

THIS 100% forced convection furnace is just one unit of the highly specialized equipment used in making "Double Diamond" gears. Because we manufacture gears—and only gears—we avail ourselves of every kind of improved technique and equipment that will produce completely controlled quality.

What does this mean to you? Simply this:

BETTER GEARS that offer the advantages of lower installed cost, economical and dependable service on the job for which you buy them . . . gears that do credit to your product and your reputation.

Our gear engineers are available for consultation. Just write.



In this controlled atmosphere furnace, 100% forced convection heating of gears by Automotive Gear Division insures uniform heating of every part to the desired temperature. Through the entire operation—pre-heating, carburizing, hardening and modified Marquenching or regular quenching in selected grades of oil—time, temperature and atmosphere in each zone are automatically controlled. Thus, the quality that is cut into the gear is retained.

EATON

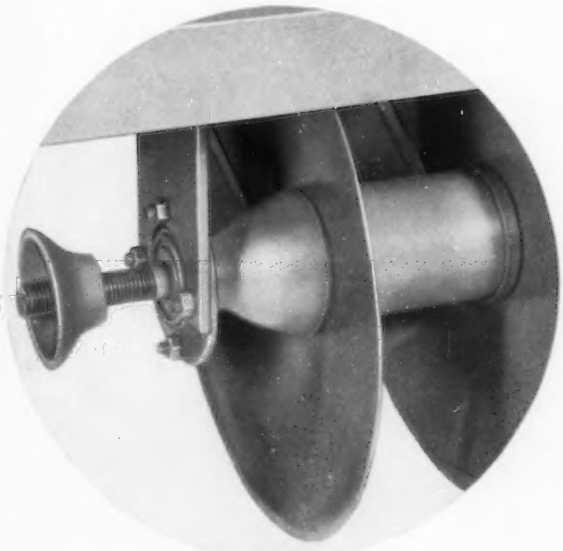
AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

(For more facts circle No. 84 on reply card)

How to pull more harrow with the same "horses"!

Oliver equips for low-draft discing with maintenance-free Fafnir Tri-Ply-Seal Ball Bearings

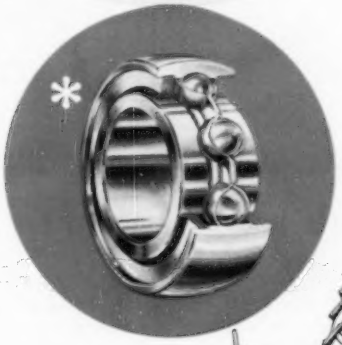


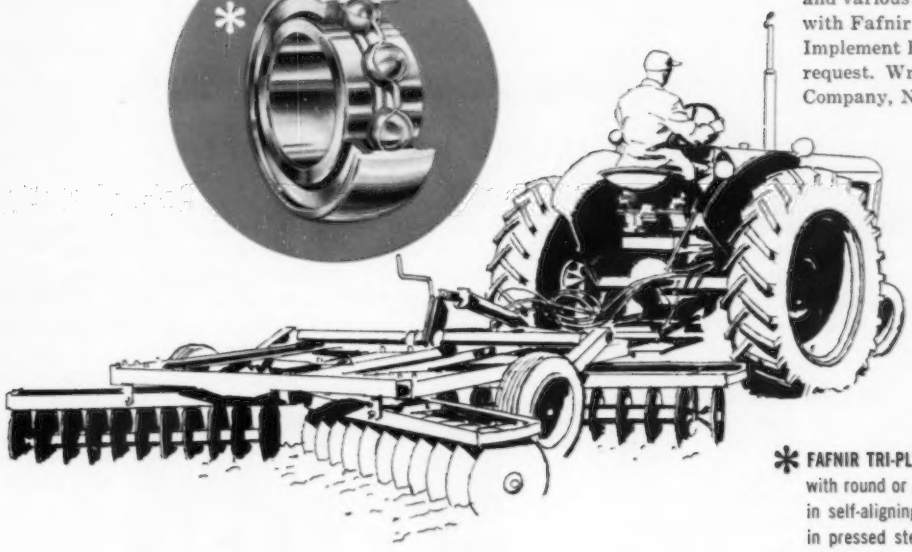
Antifriction design featuring greased-for-life Fafnir Tri-Ply-Seal Ball Bearings packs plenty of "farmer-appeal" into Oliver 241 All-Purpose Disc Harrows!

This modern, semiflexible heavyweight digs deep, yet pulls with ease . . . makes it possible to use a larger size harrow without increasing horsepower.

Tri-Ply-Seals on every ball bearing lock out all damaging dust, dirt, and moisture and prevent loss of lubricant. Bearings never need greasing, thus dirt introduced by faulty relubrication practices is eliminated. Compact, self-contained Flangette bearing housings really increase trash clearance . . . give the Oliver 241 the slenderest standard and bearing assembly. Efficient, trouble-free design any way you look at it!

Bulletin containing detailed information, complete specifications, and various mountings possible with Fafnir Tri-Ply-Seal Disc Implement Bearings is available on request. Write The Fafnir Bearing Company, New Britain, Connecticut.





FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

* **FAFNIR TRI-PLY-SEAL BALL BEARINGS** with round or square bores are available in self-aligning types for mounting in pressed steel Flangette bolt-on housings, or in cast iron housings. Rigid types for trunnioned, self-aligned housings with straight bores are also available.

(For more facts circle No. 61 on reply card)

TIMKEN-DETROIT® PUTS POWER TO WORK
...harvesting mountains of wheat!

This self-propelled Allis-Chalmers combine, equipped with a Timken-Detroit driving assembly, harvests mountains of wheat with almost effortless ease. It is another outstanding example of the successful cooperation between leading builders of farm equipment and Rockwell-Standard Corporation.

The driving assembly used here came from the complete line of Timken-Detroit axles for farm equipment. By "customizing" a standard assembly to meet Allis-Chalmers' needs and specifications, our engineers were able to provide the exact driving unit required. Result: the manufacturer was able to avoid the high cost of a new, "one-of-a-kind" component . . . get into production faster . . . and eliminate the expense of additional facilities.

Once again, Rockwell-Standard proved it is more economical for builders of farm equipment to draw on specialists for their special needs. If you have a problem in designing or building farm equipment, call in Rockwell-Standard axle engineers. It costs you nothing, and it will prove very helpful.

Plants at: Detroit, Michigan
Oshkosh, Wisconsin • Kenton and Newark, Ohio
New Castle, Pa.

TIMKEN Detroit AXLES
ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN
Accepted SAE Standard

©1958, R-S Corp.

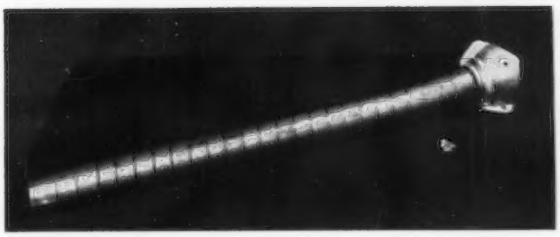
Another Product of **ROCKWELL-STANDARD** Corporation

Installing fertilizer feed cup receivers and tubes made of Armco ALUMINIZED STEEL. Small photo shows close-up of finished parts. They need no painting for corrosion protection.

Why Armco ALUMINIZED STEEL Improves Farm Equipment, Cuts Production Costs

Agricultural engineers are designing more and more Armco ALUMINIZED STEEL into farm equipment parts to assure longer service life, cut production costs.

For example, one of the largest manufacturers of farm machinery now uses Armco ALUMINIZED STEEL Type 2 fertilizer feed cup receivers and tubes for grain drills. These parts were formerly made of galvanized steel and painted. ALUMINIZED STEEL needs no paint for corrosion protection . . . eliminates a costly operation.



Longer Service Life

This special steel has a tightly adhering aluminum coating applied by a patented continuous hot-dip process. Because of its excellent resistance to atmospheric corrosion, ALUMINIZED STEEL provides longer service life for many parts and products that are used out-of-doors.

For complete information on the properties of Armco ALUMINIZED STEEL Type 2, just fill in and mail the coupon. Or call your nearest Armco Sales Office.

New steels are born at Armco

ARMCO STEEL CORPORATION, 2218 Curtis St., Middletown, Ohio

Send me complete information on Armco ALUMINIZED STEEL. We manufacture_____

NAME _____

POSITION _____

COMPANY _____

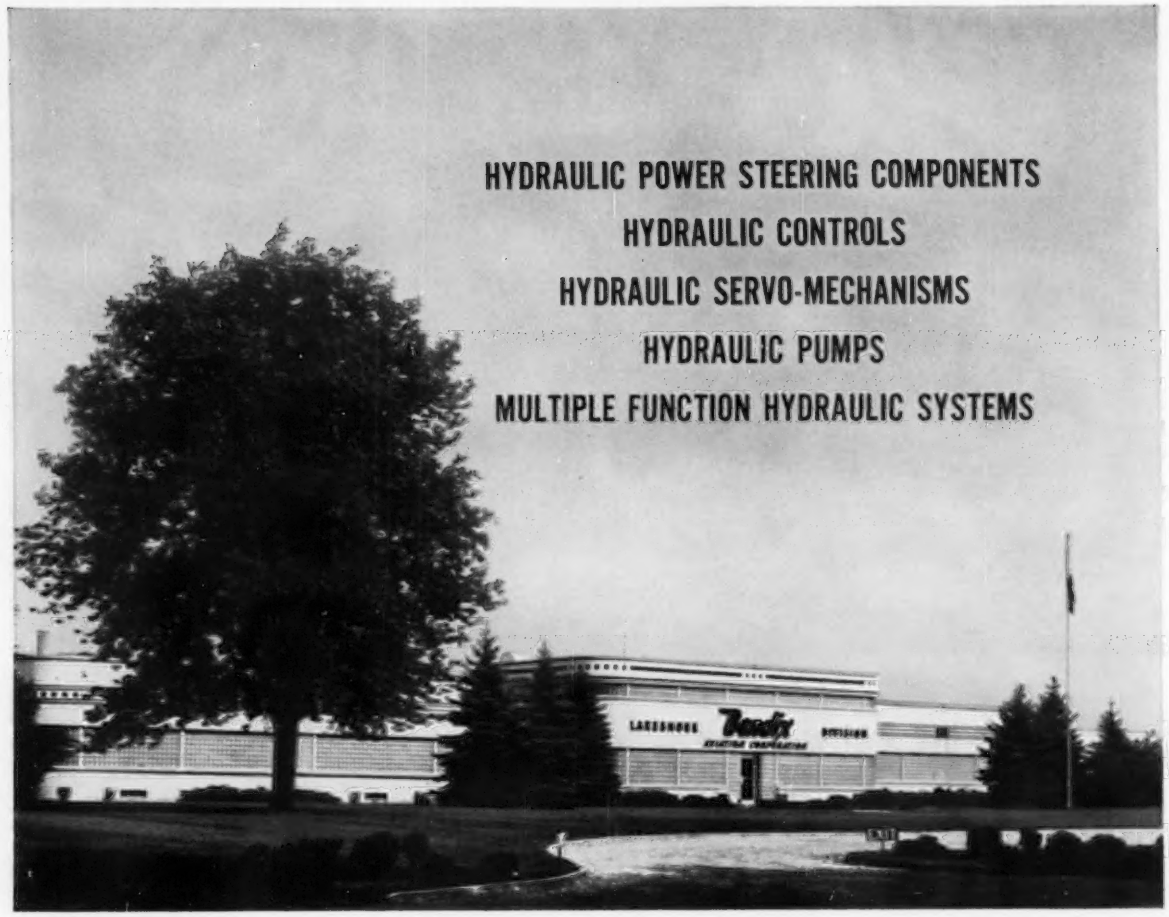
STREET _____

CITY _____ ZONE _____ STATE _____

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

(For more facts circle No. 63 on reply card)



IT'S BENDIX-LAKESHORE FOR COMPLETE HYDRAULIC ENGINEERING AND MANUFACTURING

—Automotive or Agricultural—

Whatever your needs in agricultural or automotive hydraulic components, you'll be wise to look first to Bendix-Lakeshore. One of the newest and most modern divisions of the great Bendix Aviation Corporation, Bendix-Lakeshore is geared to provide you with fast, efficient service on any product, whether it's designed by our own skilled engineering staff or produced here from your design.

Despite being a comparatively new division, Lakeshore is old in experience. Backed by the great resources of Bendix Aviation Corporation, it is staffed in large part by engineers who have spent an aggregate of hundreds of years in hydraulic research and design, both with Bendix* and other firms. Solid engineering research and extensive testing are standard procedure with us. When you order hydraulic components from Bendix-Lakeshore, you get the benefit of complete engineering facilities.

Bendix-Lakeshore's reputation for quality in the field of hydraulic components has helped us acquire, in the space of five years, a list of customers whose standards are beyond question. Remember, if you have a problem in engineering or manufacturing of automotive or agricultural hydraulic components, it will pay you to investigate the facilities and abilities of Bendix-Lakeshore in these specialized fields.

*TRADEMARK

Lakeshore Division
St. Joseph, Michigan

Bendix
AVIATION CORPORATION

(For more facts circle No. 64 on reply card)

Report to Readers . . .

PLASTIC FACING AIDS PLOW SCOURING IN STICKY SOIL

The soils of high colloidal clay content in Hawaii are extremely sticky when wet, so much so that it has been said they make a moldboard plow into a bulldozer. To help solve the problem of soil stickiness, the agricultural engineers at the Pineapple Research Institute tried surfacing the plow bottoms with a (duPont) plastic-flurocarbon resin. This made it possible to use moldboard plows and to cut plowing time in half. Further study led to improved methods of surfacing with the plastic, thereby cutting down on wear, also on cost of the plastic . . . . . Studies are now being made of this surfacing in soils of the United States, and another area of investigation is the balance of higher costs of surfaced moldboards with savings in time and motive power.

LATE RESEARCH BREAKTHROUGH IN CONTROLLED-ATMOSPHERE APPLE STORAGE

Two agricultural engineers at the University of Massachusetts have just announced an important new development in controlled-atmosphere (CA) apple storage. They have hit upon the idea of using intermittent time clocks on carbon dioxide scrubbers. This inexpensive solution of the problem of programing scrubber operation is obtained by wiring a clock into the power-supply circuit for the scrubber fan and circulating pump. Applying this idea, a commercial storage plant is now using one scrubber for two rooms, where heretofore one was required for each room. . . . . This development is the first step toward providing automatic control of the CA process.

MECHANICAL FEEDING OF FORAGES MAY BE PRACTICAL IN STALL BARNS

Mechanical feeding of hay and silage in stall barns may become economically feasible for dairy farmers in the not too distant future. That is the prediction of University of Wisconsin agricultural engineers, who have been experimenting with mechanical barn feeding at the University's electric research farm. . . . . They devised an experimental auger conveyor which delivers measured amounts of chopped hay or silage from the storage area to each stall in a conventional stanchion barn. Openings in the trough of the conveyor above the manger, adjustable to provide measured amounts, allow the feed to drop into the mangers. The installation isn't much larger than an outside automatic feeder. The engineers estimate the cost of such a mechanical-feeding setup at around $150 per cow. . . . . As dairy herd size increases, made possible by more mechanization of related operations, mechanical barn feeding may well become an important link in the dairy production chain.

UPRIGHT SILO CAN DOUBLE AS SHELLED CORN STORAGE

Agricultural engineers at Cornell University report that an upright silo can probably be used to store shelled corn. This opinion is based on one year's trial with a 16 x 45-ft concrete-stave silo. To adapt this silo to the storing of corn, it was necessary only to add an aeration system. This consisted of (1) a perforated steel drum about the size and shape of a 50-gal oil drum placed upright on the silo floor and (2) an 18-in. tubular duct connected with the drum and extending to the outside of the silo through the lowest door. An 18-in. barn ventilating fan was used to draw air through the corn and exhaust it via this duct. . . . . While one year's trial is not conclusive, since they experienced no difficulty, the Cornell engineers believe that almost any upright silo in good condition can be adapted for storing properly dried shelled corn.

PASTURING CATTLE BUFFET STYLE BOOSTS PRODUCTION, CUTS WASTE

Early results of studies by USDA and state researchers, as we noted last month, indicate green-chop feeding of dairy cattle may be more profitable than grazing, since grassland feed can be used more efficiently when green-chopped. . . . . Farm equipment manufacturers have been anticipating this trend for some time. One of them (Deere) recently issued a factual bulletin on "mechanical harvesting," prepared by an Iowa State College agricultural engineer, in which the author deals at some length with the economics of the subject. The company has supplemented this with illustrations and brief descriptions of its various machines and supplementary equipment which its engineers have developed for harvesting and handling forages. . . . . Whether the term "mechanical harvesting" or some other survives the test of general use to denote this new system of feeding cattle, in which both farmers and researchers are indicating enthusiastic interest, it is of only minor importance. Certainly it is one of the big engineering developments in the area of farm materials-handling that seems certain will progress rapidly from here on.

FARM MACHINE CONTROLS AT OPERATOR'S FINGER TIPS

In evaluating the achievement of engineers in reducing hand-labor input in agricultural production, one of the things that stands out most prominently is the notable progress made toward more convenient, more complete one-man control that an operator has over the two or more pieces of equipment he may be using simultaneously. A reminder of this is the announcement of a new, five-way control system for a forage harvester (New Holland), which includes (1) discharge-spout control, (2) harvester-engine control, (3) control of discharge-spout deflector hood, (4) lever to raise and lower attachments, and (5) forward-stop-reverse lever for the harvester mechanism. In fact, the system provides complete operating control of the harvester from the seat of the tractor pulling it. . . . . This piece of equipment is typical of many examples of advanced design coming off engineering drawing boards in farm equipment factories. It is one of the many indications of the general urgency confronting engineers to keep pace with the readiness of more and more farmers to go the limit in mechanizing their operations for improved efficiency and economy.

TWO-WAY APPROACH TO CUTTING SEED CROP HARVESTING LOSSES

When seed losses from harvesting the major grass and legume crops mount to 60 percent and sometimes more, it is high time to find out the reasons therefor and undertake to do something about it. One USDA agricultural engineer in collaboration with agricultural scientists at Oregon State College has been doing just that, and their studies thus far indicate that a large percentage of the seed crop loss can be prevented in two ways: (1) by improved harvesting equipment and (2) by better timing of the harvest. . . . . These researchers found that losses were heaviest, for example, in the case of hard-to-harvest subterranean clover that hugs the ground and leaves about 80 percent of its seed in the field in the wake of the combine. Then they made tests with a suction-type seed reclaimer, with the result that they were able to cut harvest losses to less than 10 percent. . . . . Next attention was turned to timing the harvest. Certain seed crops were harvested by the windrow-combine method at weekly intervals beginning three weeks before the normal harvesting. Tests showed that harvesting two weeks prior to the normal time gave 50 to 100 percent more seed with the windrow-combine method. Also, germination tests showed only small loss in the case of the early harvested seed. . . . . Another advantage of early harvesting of seed crops lies in providing flexibility for farmers to avoid last-minute gambling with the weather.

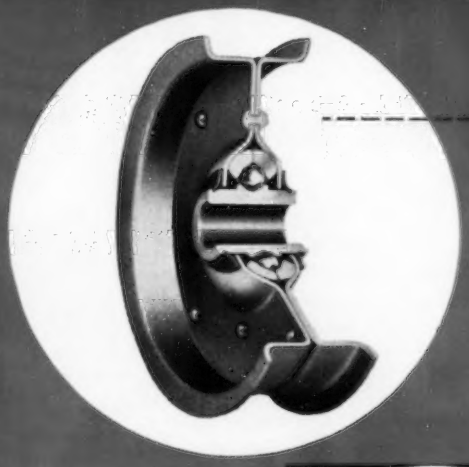
- TIME SAVERS
- COST CUTTERS
- PROVEN PERFORMERS

BCA ball bearing "package units"

Designed specifically for agricultural equipment, BCA "package units" simplify assembly line installation and reduce production costs.

Bearing, housing and an efficient seal are combined in a single, pre-lubricated, rugged "package unit". They are built to handle with ease the loads and speeds encountered in service.

BCA, backed by half a century of experience in the design and manufacture of ball bearings, will work with your design and engineering departments on special application problems. BCA "package units" will be developed in sample or production quantities. Address Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.



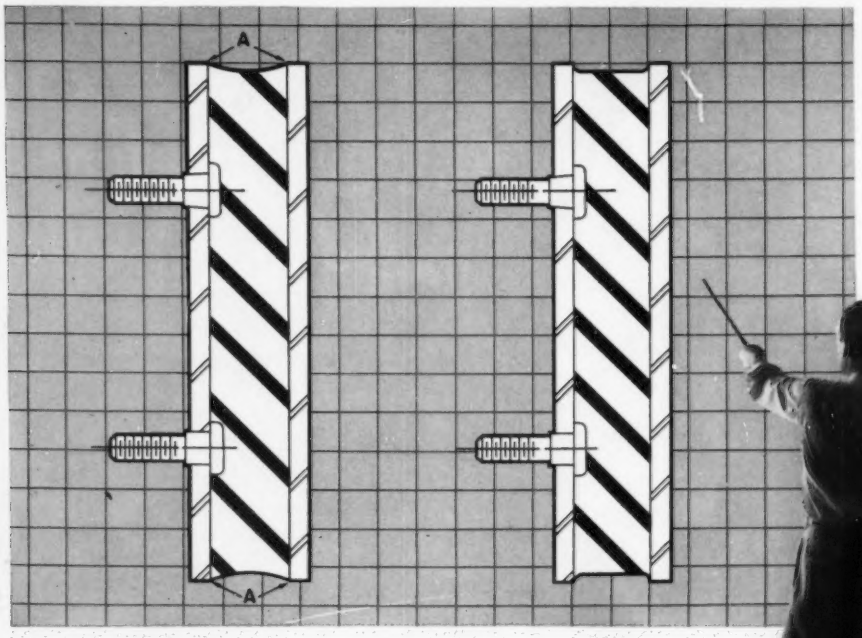
BCA IDLER PULLEY ASSEMBLY

Pulley, bearing and seal—all in one complete package unit. Pre-lubricated bearing effectively sealed against dust and grit. Simple, rugged construction eliminates frequent field servicing. Adaptable to many agricultural applications, including: corn pickers, hay balers, grain elevators, cotton pickers. Idler design can be varied for use with flat belts, V-belts or chains.

BCA

BEARINGS COMPANY OF AMERICA
DIVISION OF
Federal-Mogul-Bower Bearings, Inc.

(For more facts circle No. 65 on reply card)



Savings in molded rubber parts begin with improved design

thru **ORCO**

CUSTOMEERING

Similar designs? Almost, but not quite. In the design at left, "A" is a stress point. The shrinkage of the rubber can cause concentrated strain at the edges of the bonded area. Ohio Rubber engineers would probably recommend the design shown at right.

Attention to important details like this is typical of ORCO's "customeering" of parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, whether they be molded, extruded, or bonded to metal.

From components weighing less than a gram to parts of over 73 lbs., whatever the shape involved, ORCO's integrated research, design, electronically controlled compound mixing, and production facilities, assure component uniformity and quality to meet the most exacting requirements. Check with ORCO engineers on your next rubber or vinyl component problem. Your inquiry will receive prompt attention.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

THE OHIO RUBBER COMPANY

A Division of The Eagle-Picher Company
Willoughby, Ohio

(For more facts circle No. 66 on reply card)

NEW! LOOK AT THE 14 POINTS WHERE ALLIS-CHALMERS D-14 TRACTOR RELIES ON NATIONAL SEALS

Center Main Drive Shaft (2 seals)
Rear Main Drive Shaft (2 seals)
Rear Power Take-off (1 seal)
Front Crank Shaft (1 seal)
Front Power Take-off (2 seals)
Rear Axle (2 seals)
Center Pinion Shaft (2 seals)
Control Shaft Torque Tube (2 seals)

At 5 positions in the new D-14, Allis-Chalmers specifies steel-encased, spring-tensioned National leather oil seals. Two additional positions employ steel-encased, spring-tensioned Syntech® synthetic rubber seals. At still another position, the control shaft torque tube, a springless rubber-covered National Syntech is used.

All National seals in the D-14 (and many in Allis-Chalmers' equally new D-17 tractor) are standard design National seals. National supplies over 2,500 different types and sizes of oil seals, leather or synthetic. New seals are being designed daily to meet special applications.

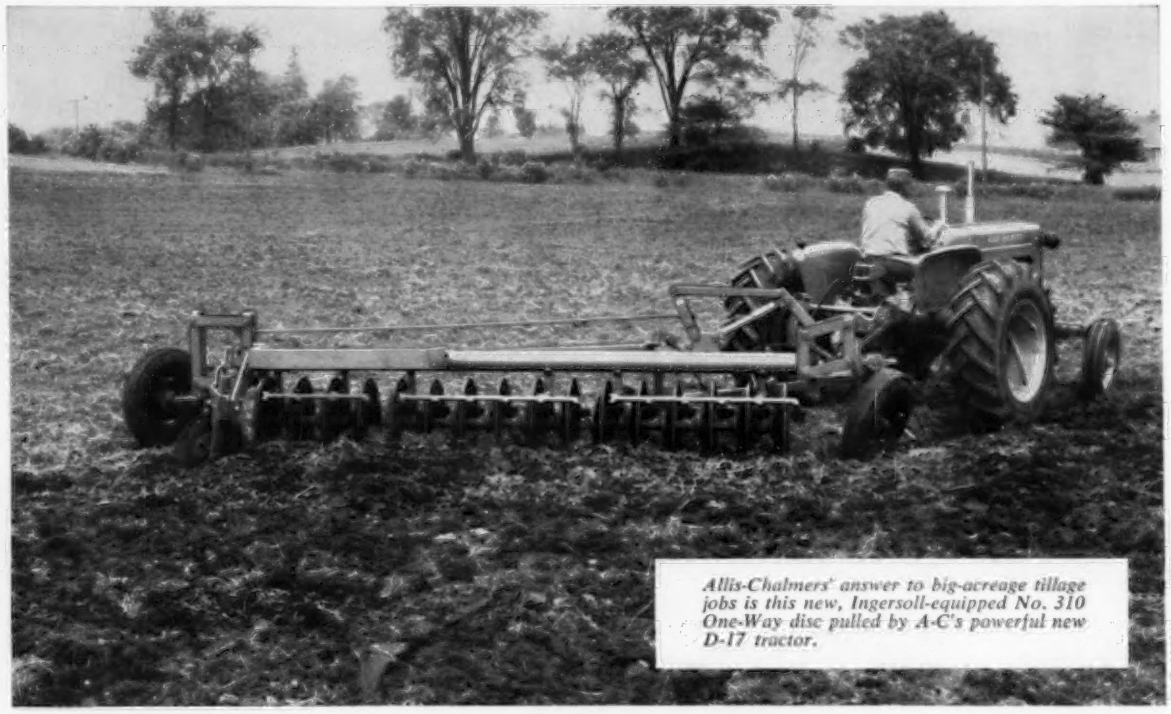
For factual, professional engineering help on any shaft sealing problem, call your National Applications Engineer. He's listed in the Yellow Pages, under "Oil Seals—National Seal Division." He's backed up by 36 years of sealing experience, and the productive capacity of three modern plants.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

4589

(For more facts circle No. 67 on reply card)



Allis-Chalmers' answer to big-acreage tillage jobs is this new, Ingersoll-equipped No. 310 One-Way disc pulled by A-C's powerful new D-17 tractor.

Ingersoll Discs ...built for the BIG JOBS

Wherever the fields really stretch out, this Allis-Chalmers "Big-Power" team gets the tillage jobs done fast.

Equipped with sixteen husky 24-inch Ingersoll discs, that brawny A-C No. 310 one-way rips along at a sod-busting, stubble-chopping clip that shaves precious hours off tight working schedules.

Allis-Chalmers, like *all* leading manufacturers, equips its implements with rugged and reliable Ingersoll discs. They're made of TEM-CROSS® steel—a special tillage steel that's *cross-rolled* and specially heat-treated to resist impact and abrasion, hold a sharp edge longer and stand up to the tough jobs without splitting, curling or warping.

Be sure to recommend Ingersoll discs whenever *you* sell replacements. That way you restore original equipment quality to the implement and give your customers the most for their money.

INGERSOLL PRODUCTS DIVISION
Borg-Warner Corporation, Chicago 43, Illinois

SPECIALISTS IN TILLAGE STEELS • WORLD'S LARGEST MANUFACTURER OF DISCS
EXPORT SALES: Borg-Warner International, 36 S. Wabash, Chicago 3, Illinois

THE ONLY MANUFACTURER OF DURA-DISC — THE STEEL THAT IS THE ECONOMICAL REPLACEMENT FOR HIGH COST ALLOYS

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Selecting the right grade of nuts

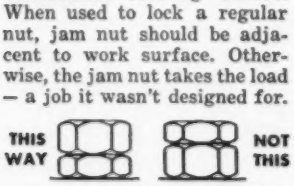
"Workhorse" among nuts is the standard "FINISHED" series. It gives good seating area; sufficient height to sustain high thread tension; enough wall thickness to control elastic nut dilation under load.

"HEAVY" nuts are wider than "Finished" nuts in *all* sizes by only ⅛" across flats. Thus, their value diminishes as size increases. Most effective in ½" to 1½" range, they satisfy applications involving excessive clearance holes, unusual loads, and certain boiler codes.

MATERIALS? The regular carbon nut steel (non heat treated). It makes nuts strong enough to pull bolts beyond yield point, lets threads distribute load to avoid stripping.

NUTS WITH "SPECIAL" FUNCTION

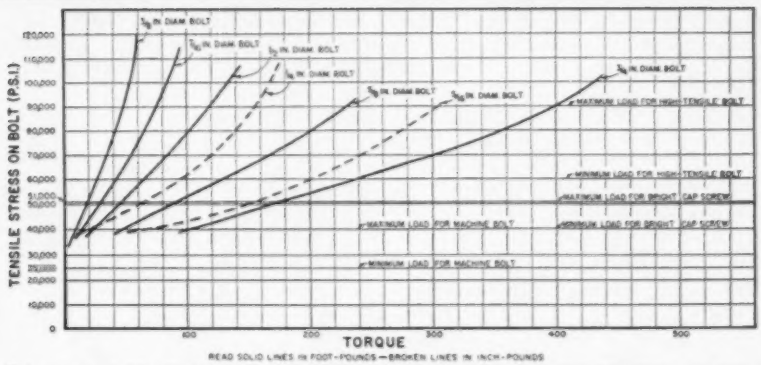
JAM NUTS are made for position locking. Use of two together forms a superior and economical locking device. When used to lock a regular nut, jam nut should be adjacent to work surface. Otherwise, the jam nut takes the load — a job it wasn't designed for.



Use a 2H NUT where high temperatures call for stability.

HIGH NUTS are used for shackle, U and tractor pad bolts. They're furnished only in fine threads, therefore, and hardened. More to be recommended are *coarse thread* finished nuts.

Tightening up fasteners tightens down on costs


TENSILE STRESS ON BOLT (P.S.I.)
TORQUE
MAXIMUM LOAD FOR HIGH-TENSILE BOLT
MINIMUM LOAD FOR HIGH-TENSILE BOLT
MAXIMUM LOAD FOR BRIGHT CAP SCREW
MINIMUM LOAD FOR BRIGHT CAP SCREW
MAXIMUM LOAD FOR MACHINE BOLT
MINIMUM LOAD FOR MACHINE BOLT

These curves suggest torques for proper tightening of three grades of standard fasteners. Tightening to the upper limits delivers more of the holding power paid for, and assures stronger joints. Dropping below minimum values wastes fastener strength, invites loosening and failures. These curves are reproduced in RB&W Booklet DC-1.

It pays to go the limit in tightening bolts. Not only is it more economical, but safer too. For strength of a rigid connection depends on *residual tension* rather than on how strong the bolts are. Applying this fact can help avoid cost penalty.

EXAMPLE:

Blueprint specifies alloy bolts with strength of 145,000 psi. But assembly specification calls for tightening to what has been found an adequate pre-loading . . . only 30,000 psi. This wastes the fastener's capacity. It provides no more joint-strength than supplied by a *far more economical* RB&W bright cap screw tightened to same pre-load. It would be better to switch to the lower grade, or reduce size of the premium grade fastener.

REDUCING SIZE ALSO SAVES

A fastener's holding power is the same as its pre-load, or residual tension. So long as it permits tightening to the required pre-loading, the bolt can be small as possible.

EXAMPLE:

Design requires fasteners with safe load capacity of 20,000 lbs. Bright cap screws of ¾" size will do it; but so will ⅝" RB&W High Strength Bolts — *at less cost*. Actually, for the same holding power as in $1.00 worth of high tensile fasteners, $1.50 worth of bright cap screws are required.

PRODUCTION BENEFITS

Along with direct savings, smaller bolts mean smaller holes to drill or tap. Smaller holes often allow reduction in size of fastened members.

Talk to an RB&W fastener expert at the design stage of your product. He can help you cut costs without cutting joint strength.

Meanwhile, send for helpful booklet DC-1. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

(For more facts circle No. 69 on reply card)

KOHLER ENGINES

4-CYCLE SHORT-STROKE AIR-COOLED

MODEL

K330

- Balanced crankshaft — ball bearings at both ends
- Gear pump supplies oil under pressure direct to connecting rod bearing, other moving parts
- Rugged automotive diaphragm fuel pump with manual primer
- Stellite exhaust valve and seat with positive rotator
- Mechanical governor for accurate R.P.M. control

POWER—*IN Action*

Kohler engines, conservatively rated, will do the jobs for which they are recommended.

Kohler quality—recognized and respected throughout the world—is built into every engine.

FROM 3 TO 24 H.P. *Send for 28-page illustrated booklet*

KOHLER CO. Established 1873 KOHLER, WIS.

KOHLER OF KOHLER

Enameled Iron and Vitreous China Plumbing Fixtures • Brass Fittings • Electric Plants • Air-cooled Engines • Precision Controls

ALL DAY—WITHOUT ONCE FIGHTING THE WHEEL!

Power Steered Tractors make farming easier . . . more efficient . . . safer!

Your tractor customers will never again be happy with muscle-steering—not after they've tried Bendix* Power Steering! And here's why . . .

It's easier! Wheel fight and shock are eliminated—even on roughest ground. One hand gives complete control—for short turns or straight furrows. At day's end, the operator is still fresh—ready for the evening chores.

It's more efficient, safer, too! Easier steering means straighter furrows, less damage to growing crops, less time lost doing jobs over. And it is important to remember that better control reduces the danger of accidents.

The fact that Bendix is the foremost producer of power steering for trucks, passenger cars, buses and off-the-road equipment, as well as for farm tractors, is your definite assurance of satisfactory, trouble-free performance.

And because Bendix Power Steering is adaptable to existing steering linkage, tractor manufacturers can make production line installation without costly engineering changes.

*REG. U.S. PAT. OFF.

Bendix PRODUCTS DIVISION South Bend, IND.

Bendix AVIATION CORPORATION

(For more facts circle No. 71 on reply card)

Since 1903

PARTNER

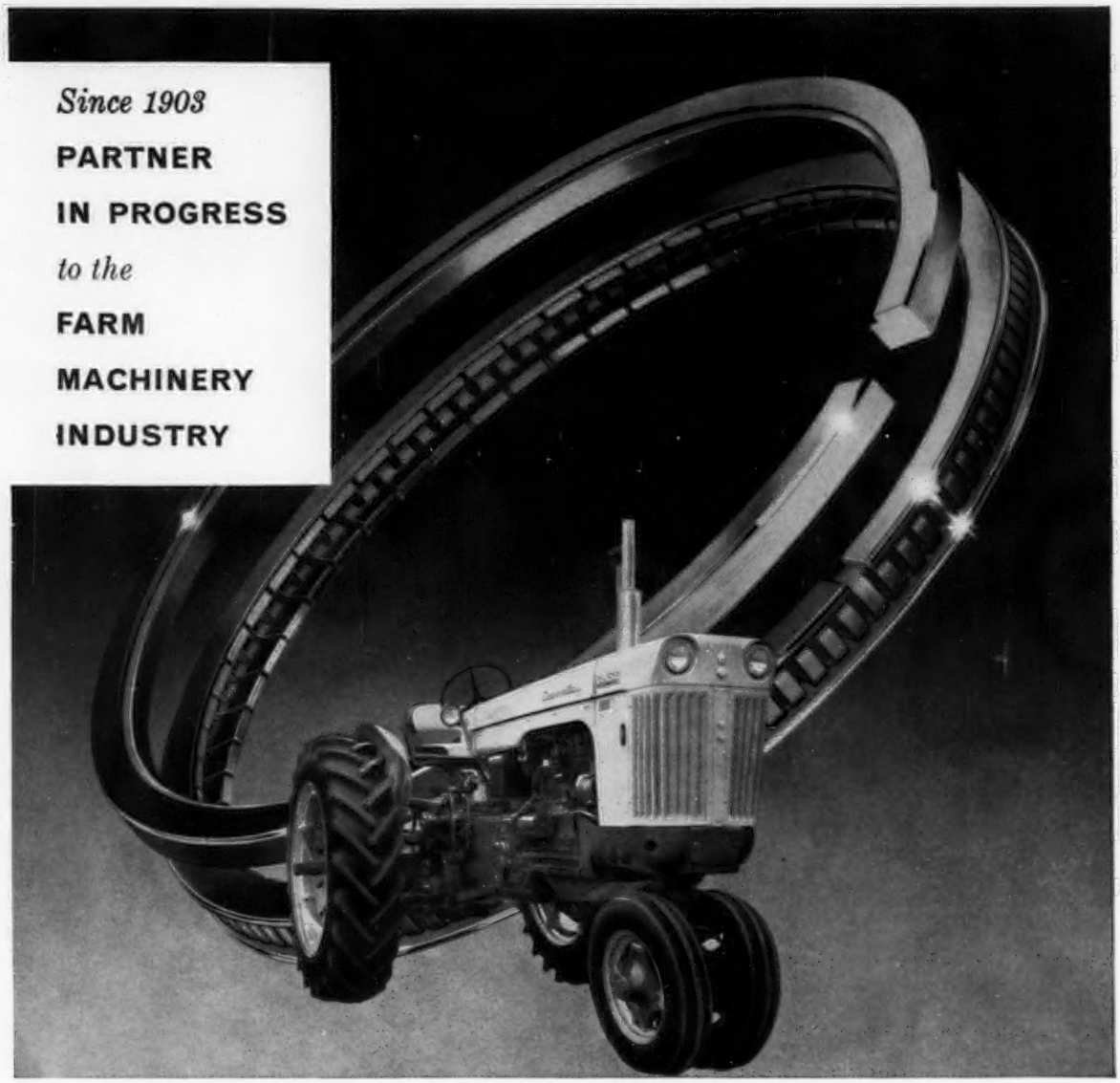
IN PROGRESS

to the

FARM

MACHINERY

INDUSTRY



J. I. CASE—one of the leading engine manufacturers using Perfect Circle piston rings for both original equipment and service requirements.

When you look into the reasons why the name "Perfect Circle" has become a world-wide synonym for excellence in piston rings, three basic factors emerge: research facilities, engineering leadership, and manufacturing skills unmatched in the industry.

Whenever you have a problem concerning piston rings or their application, you are invited to consult with our research and engineering "team." Perfect Circle Corporation, Hagerstown, Indiana; The Perfect Circle Co., Ltd., Don Mills, Ontario, Canada.

PERFECT CIRCLE PISTON RINGS

Agricultural Engineering

June, 1958
Number 6
Volume 39

James Basselman, *Editor*

Farm Equipment Industry Prospects Up

CURRENT prospects of farm equipment industry have improved says the Value Line Investment Survey in a new report released June 2. Following are statements taken from that report:

"For the first time in several years, the grass is greener for the farm equipment makers than for other durable goods producers. Reason: farm income is one of the few strong spots in our economy. The improvement in farm income is confounding the experts who have always assumed that farmers could enjoy prosperity only in a rising economy.

"Prices of farm products are running well above last year. Outlays to farmers for participation in the Soil Bank are larger. Due to last year's delayed harvests, some of net farm income was deferred to the opening months of 1958. Net farm income is expected to average 5 to 10 percent higher for the year as a whole than in 1957.

"Most agricultural equipment manufacturers have benefited from the unexpected upturn in farm income. The current rise in sales has bolstered earnings prospects. Dividend rates which were formerly in jeopardy now appear likely to be maintained."

The report revealed that the Value Line Investment Survey sees some farm equipment equities still meriting consideration by investors, even at current advanced prices, and based on latest trends it has raised its estimate of 1958 net farm income to $12.4 billion from the $11.5 billion tentatively estimated three months ago.

Engineering Enrollment Survey

FOLLOWING is a summary of the principal findings of the 1957 annual survey of engineering enrollments and degrees in colleges which have one or more curricula accredited by the Engineers' Council for Professional Development. The survey covers 152 such colleges in the United States and its possessions. The survey is made by the U.S. Office of Education in cooperation with the American Society for Engineering Education.

1 Total engineering enrollment in the United States and its outlying parts in institutions accredited by ECPD reached an all-time high of 257,777 students in the fall of 1957. This represented a 5.5 percent rise over the previous peak of 244,390 students reported in 1947.

2 Engineering enrollment has shown year-to-year increases since 1951.

3 In the fall of 1957, total male engineering students in ECPD-accredited institutions made up 12.8 percent of total male degree-credit enrollment, compared with 12.5 percent a year earlier.

4 The enrollment of 67,071 freshmen in the fall of 1957 was 1.0 percent higher than the previous year. All other classes of enrollment in ECPD- accredited institutions, except sophomores, also showed increases.

5 Part-time and evening undergraduate engineering enrollment in the fall of 1957, reported 30,458 students, was 17.1 percent above the year before.

6 Enrollment for the master's degree in the fall of 1957 in ECPD-accredited institutions increased 7.6 percent from the year before.

7 Enrollment for the doctor's degree in the fall of 1957 in ECPD-accredited institutions, 4,180 students, increased a substantial 22.9 percent from the year before.

8 Evening student enrollment for the doctor's degree in ECPD-accredited institutions in the fall of 1957, 690 students, increased very substantially, 30.7 percent from the year before.

9 During the 1956-57 academic year, 27,748 first-level engineering degrees were awarded by ECPD-accredited institutions — a noteworthy increase of 17.8 percent from the year before.

10 First-level degrees in engineering awarded during 1956-57 constituted 8.0 percent of the total first-level degrees (estimated), a higher percentage than the 7.6 percent observed for 1955-56.

11 A total of 5,203 master's degrees in engineering was granted by ECPD-accredited institutions — an 11.2 percent increase from the year before.

12 ECPD-accredited institutions granted a total of 596 doctor's degrees in engineering in 1956-57 — 2.3 percent fewer than the year before.

13 During the 1956-57 academic year, the highest percentage of engineering degrees awarded by ECPD-accredited institutions for first-level, master's, and post-graduate pre-doctoral degrees was in the field of electrical engineering. For the doctor's, the highest percentage of degrees awarded was in chemical engineering. The complete survey report may be obtained from W. Leighton Collins, Secretary, ASEE, University of Illinois, Urbana.

A companion report including 69 institutions accredited as a whole by state or regional accredited associations but which do not have curricula accredited by the Engineers' Council for Professional Development will be published as Circular 516, "Engineering Enrollments and Degrees, 1957," of the United States Department of Health, Education, and Welfare Office of Education.

ASAE 51st Annual Meeting • Santa Barbara Campus, University of California, June 22-25

Soil Reaction: To Plow Share Design

M. L. Nichols, I. F. Reed,
Life Fellow ASAE Fellow ASAE
and C. A. Reaves
Member ASAE

Plow shares of various types and shapes were submitted to a series of tests to determine effects of shape, wear, angle of approach and soil conditions

THIS ARTICLE covers a study of plow shares submitted to the USDA National Tillage Machinery Laboratory, Auburn, Ala., for appraisal by a farm equipment manufacturer. The shares represent three common cross sections in extensive use. Particular attention is given to variations in plow share shape and types of leading or cutting edges since this area of the plow bottom surface cuts or breaks the soil loose and consequently may in large part determine subsequent effect of the plow. The results of studies of soil reactions in the model testing unit, Fig. 1, are shown and discussed. This apparatus has a glass side for observing movements within the soil and instruments to enable measuring the force required to produce these soil reactions. Data for draft tests and force measurements made with full scale shares in the soil bins are included and discussed. Fig. 2 shows the equipment used for outdoor bin studies.

A study of the shares, cross sections of which are shown in Fig. 3, indicates that there would be appreciable variation in pressures developed at the cutting edge because of variation in the slope of portions of edge and because the force normal to the surface of application would vary materially for different small areas along the cutting edge. The hypothesis was developed that the effect of variations in slope or increased steepness of these areas would produce high pressure areas in the soil which would be followed by low pressure areas on the share or moldboard in the path of the soil with a tendency for sticky soils to adhere and prevent scouring in the low pressure areas. While these pressure

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors—M. L. NICHOLS, I. F. REED, and C. A. REAVES—are, respectively, former director, senior agricultural engineer, and agricultural engineer, USDA National Tillage Machinery Laboratory, Auburn, Ala.

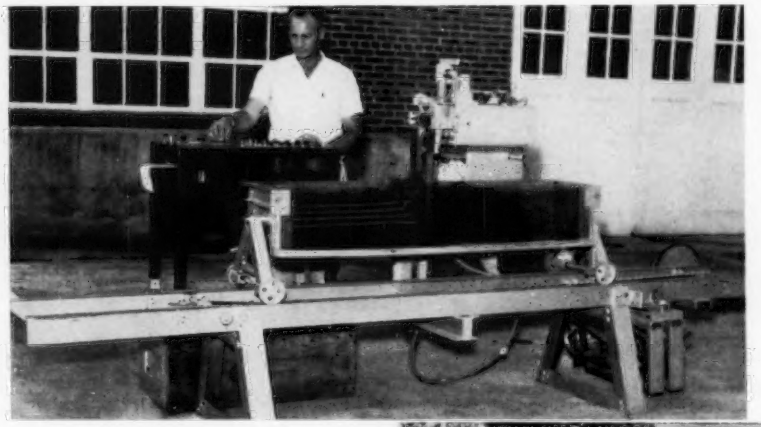


Fig. 1 The USDA Tillage Machinery Laboratory model test unit. The beam which carries the model tillage tool is mounted on a 6-cell dynamometer so that the horizontal, side, and vertical forces are measured and recorded. Forces exerted on the small pressure cells inserted in the face of the tool are recorded by use of the Sanborn unit in the background. The glass side in the soil box permits observation and study of soil actions

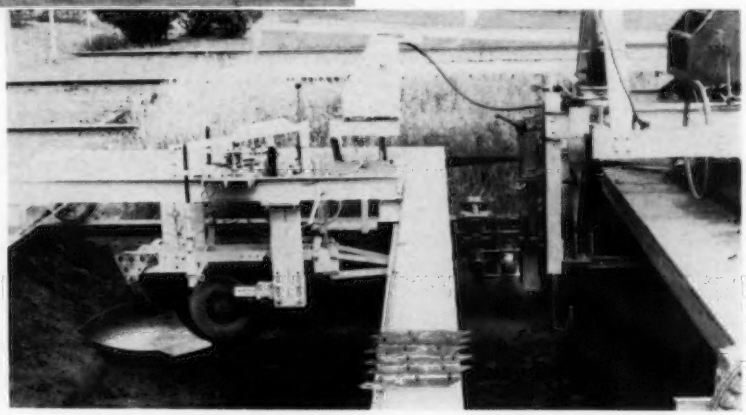


Fig. 2 The USDA tillage test unit hitched to the power car dynamometer. The 3-cell power car dynamometer hitched to the test beam and the two vertical and one side cell of the test unit with their recorders measure and record the draft, side force, and vertical force on the plow bottom. The plow shares used in this study are shown in the foreground

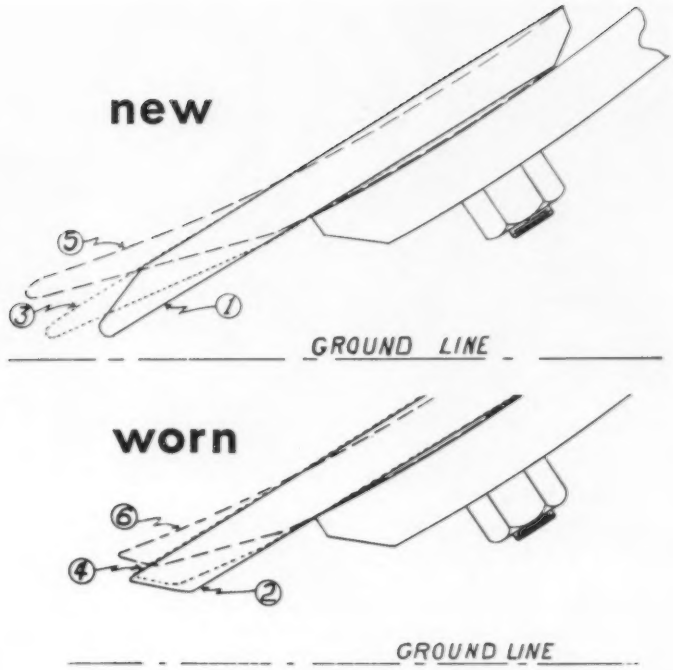


Fig. 3 Sections of the new (1, 3, and 5) and worn (2, 4, and 6) shares used in this study

areas are relatively small, being produced by the small bevel at the cutting edge, by wear, or by the thick edge of the metal of the share, their importance compared with their size is great because they are on the cutting edge of the share and may modify or control the direction and amount of pressure required to produce the first rupture surfaces or primary shear "planes" in the soil described by Nichols and Reed (1)*.

To study the effect of these variations at the edge of the share, modified sections, Fig. 4, having enlarged or exaggerated pressure surfaces at the cutting edge were made up and tested in the glass-sided box so that the extent and nature of the resulting soil reaction could be evaluated qualitatively. Since the soil during normal plowing would slide up the share and across the moldboard, a short section similar to a moldboard was inserted to approximate the path of the soil being pushed up over the moldboard by the advancement of the plow. Normally, the edge of the share moving in a horizontal plane advances into the soil at an angle of approximately 45 deg to the direction of travel. In these studies the share section was forced into the soil with its cutting edge at a 90-deg angle to the direction of travel. This tended to still further exaggerate the soil reaction.

Fig. 5 shows an adhering or entrapped wedge of soil moving before such an advancing pressure area or surface formed by the bevel on a share section similar to that of share No. 1 in Fig. 3. This wedge or cone of soil travels with the share and in effect becomes part of it. The soil ahead of this share section is compressed into a wedge or cone which presses into the soil, forcing movement in the cutting edge area upward higher than the advancing surface of the share. Movement of soil over the share, therefore, is above its surface, leaving a low pressure area—actually in some instances an open air space—as shown in Fig. 5. In less adhesive soil a beveled section was found to scour; however, the soil flow was sufficiently deflected to produce a low pressure area above it.

Fig. 6 shows the soil movement before an exaggerated blunt point or pressure surface on the edge of a plow share. The photograph was produced by moving the share section beside a glass surface covered with levigated aluminum so that particles of soil scratched traces of their own paths as they moved forward and upward. It should be noted that the wedge or cone compressing the soil ahead of the flat section was formed by pressure forward and downward and that the soil at the plow sole appears to be torn loose and shows cracks at an angle inclined to the rear. Observation of this reaction showed that the compressed area of soil before the flattened area extended below the edge of the share and that the cohesion of the soil pulled the surface upward as the share advanced through the previously compressed area. This same type reaction was found to occur with the worn shares in the bin tests. The small surface worn on the under edge of the share exerted a considerable force downward, acting like a sled runner. After the share had passed it left a roughened and loosened surface above a packed plow sole. The vertical forces causing this reaction are shown as the differences in the vertical force column for new and worn shares in Table 1 under bin tests.

Fig. 6 also shows the effect of such a cone on adhesion in a sticky soil. The soil being forced to flow around the cone formed by the flattened surface on the edge of the advancing share was also deflected upward, leaving a low pressure area on the share surface to the rear of the cone. The deflected soil moving upward and to the rear struck the moldboard at a relatively high elevation and stuck since the flow was not directed smoothly along the surface but more nearly at a normal to it. This disturbance under these critical or border line conditions for scouring caused the entire surface

*Numbers in parentheses refer to the appended references.

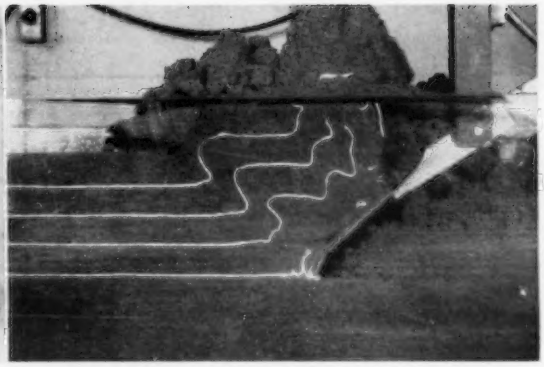


Fig. 4 *(Left)* Share sections used in model study and an arm for holding them in operating position. The beveled sections are ⅛, ¾, and 1-in. in width and slope at 30, 60, and 90 deg to the section surface • Fig. 5 *(Right)* Through the glass-sided box in Fig. 2, an entrapped wedge or cone of soil moves before a beveled surface at the share's edge with increased pressure at this point followed by a low pressure area. In this case an actual void occurs along the cone.

. . . Soil Reaction

to clog up with adhering soil and the flow pattern of soil was over a newly formed soil surface rather than on the plow surface. The soil reaction consisted of first a comprehensive action in the direction of the motion of the plow, since the pressure was highest before the cone. Then, as the cone moved forward, the pressure (as measured by the hydraulic dynamometer of the model apparatus) built up to a peak. During this advancement the entire block of soil was also under constantly increasing upward pressure because of the advancing inclined plane of the plow. As a result the cohesion of the soil was completely overcome and a shear or rupture surface developed at approximately an angle of 45 deg upward and forward. At the same time the dynamometer pressure dropped. The entire block then moved as a mass up the inclined rupture surface flowing over the soil surface of the adhering mass of soil rather than the plow surface.

Having determined the nature of the soil reaction by the exaggerated cross sections, normal share sections were studied. It was found that any area along the edge of the share that would hold the soil and exert pressure, such as a bevel or even a dull point, would produce soil reactions similar to the exaggerated shares but, of course, varying in degree in accordance with its size and inclination. The nature of the soil reaction was found to be the same for the entire range of conditions studied but the extent of the disturbance, size of cone, and adhesion varied quantitatively with soil physical properties.

In a recent paper on the rudiments of soil mechanics, W. Soehne(2) breaks down the work required for plowing as follows:

(a) The cutting work done by plow share and coulter.

(b) The connected work of turning and pulverizing where the cohesion and shear forces in the soil must be overcome.

(c) The lifting and acceleration work done on the furrow slice.

(d) The work done to overcome the friction between the soil and moldboard.

(e) The work done to overcome the friction between the soil and the landside and sole.

This breakdown indicates the complexity of the operation and thus the difficulty and precision required in evaluating the effects of changes of design of any one part of the plow bottom since a change in one part may affect the work of the other parts. To simplify this study of the effect of shares, the three designs of shares (Fig. 3)—both new and worn—were used on the same plow bottom so that the work in items *(c)* and *(d)* in a scouring soil condition should be essentially the same for all tests in a bin. The furrow wall in the bin tests was cut by a coulter mounted on the frame supporting the plow so that its work (item *a*) was excluded from measured force reactions. No attempt was made in the bin tests to measure the work of turning on the moldboard (item *b*) since it was essentially the same for all shares in these full scale tests where no adhesion sufficient to materially affect scouring occurred. It should be noted that these conditions were radically different from those described in the work with the model apparatus where adhesion of the soil to moldboard occurred and scouring was prevented. Examination of soil in the bin tests after plowing indicated no significant variation, measurable by available apparatus, in pulverizing action (item *b*) of any of the shares under the conditions of these tests. The bottom was operated without a landside. The side forces were taken on cells in the plow test and dynamometer units so there was no work caused by landside friction (item *e*). This leaves the force required in the cutting loose of the furrow slice on the plow sole (item *a*) and the friction on the bottom of the furrow (item *e*) as the main cause of variation of draft in these controlled bin experiments. The differences in draft and vertical forces on the plow bottom as shown in Table 1 are, therefore, largely caused by the effects of changes at the cutting edge of the share.

To measure accurately variations in draft caused by variations in the edge of the share, soil conditions must be controlled within close limits. Adequate control for this type of measurement is provided in the bins of the Tillage Machinery Laboratory. Soil conditions can entirely obscure the effect of a change of the design of the share. For example, where the soil has dried out with resulting shrinkage, it is subject to stresses which may be near the yield point, and will break up into lumps or pieces. The breaking up follows a pattern already impressed on the soil by the drying and has

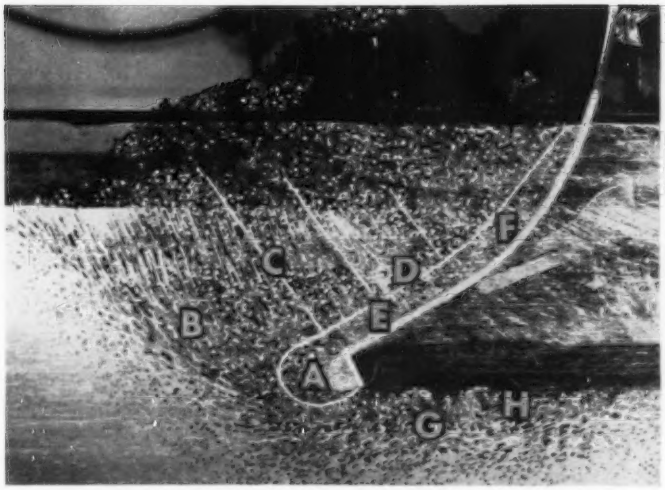


Fig. 6 Soil reaction to advancing share section as viewed through the glass side of the model test bin. The inside of the glass was covered with levigated aluminum, thus permitting the moving soil particles to trace their own paths. The share section has a large flat surface at its leading edge to exaggerate or magnify the nature of the soil reactions. (A) is the cone of soil advancing before the share. (B) is the compression area in front of the cone. (C) indicates shear or rupture surfaces. (D) is the flow line of soil up the plow surface. (E) is a low pressure area. (F) is a high pressure area causing adhesion. (G) shows the soil torn loose on plow sole because of cohesion of soil in compressed area

an indeterminable relationship to the stresses imposed by the share. When the surface of the soil is compact and the soil loose at share depth, the share will not perform its normal function of producing primary rupture planes, leaving them to be formed by the moldboard. Thus, the effect of the variations of the share's edge will become insignificant or obscured. If the soil adheres to the plow and does not scour, as shown in Fig. 6, the properties of the soil, *not the shape or design of the plow*, determines its entire functioning. In order, therefore, to appraise the value of relatively small changes in design of the share on total draft, the Lloyd clay and Hiwassee sandy loam soils in the bins were prepared in such a manner that the condition of the soil in the area of the share was of relatively major importance to the plow action and the surface of relatively minor importance. This was accomplished by subsurface packing in the soil firmly at the 3½ to 6-in. depth and plowing 5 in. deep. The soil surface elevation, plowing depth, and width of cut were precisely controlled by working from the rails of the bins. The bulk density of the Lloyd clay at the 0 to 2½-in. depth was 1.20 and at the 3½ to 6-in. depth 1.24. The Hiwassee sandy loam had a surface bulk density of 1.55 and at 3½ to 6-in. depth of 1.69. The importance of the physical conditions at share depths was increased in the Lloyd clay soil by decreasing the resistance of the surface by moistening it so the moisture content was 22.6 percent of water in the surface and 21.9 percent in the 3½ to 6-in. layer.

In the Hiwassee sandy loam the surface dried before the test could be run so that the moisture contents were 7.9 percent at the surface and 9.9 percent at plow depth. Table 1 shows the draft, and vertical and side forces on the plow, giving the average data for four replications. The odd numbers are new shares and the even numbers are worn shares, the no. 2 being the worn no. 1, the no. 4 the worn no. 3, and the no. 6 the worn no. 5 as shown in Fig. 3.

TABLE 1. BIN TEST DATA — PLOW SHARES

Share no.	Hiwassee sandy loam Draft	Vertical force*	Side force	Lloyd clay Draft	Vertical force*	Side force
1	300	77	65	317	25	73
3	288	105	53	266	51	66
5	270	74	58	290	33	64
2	287	—21	61	333	—92	49
4	275	15	50	333	—74	57
6	260	12	64	435	—164	60

*Negative vertical force indicates that weight is required to hold the plow bottom to depth.

Data for all tests: Speed, 3 mph; depth, 5 in.; width, 14 in.

The bin tests were run at 3 mph with the plow at a precise depth of cut of 5 in. and width of cut of 14 in. It was noted that the worn shares required more weight to hold them at required depth and there was a tendency for adhesion cracks to form on the furrow bottom as shown and discussed for models in Fig. 6. The average draft of shares no. 3 and no. 5 reversed with the two soils. The values of replicates, however, covered the same range for both shares and it was considered that, with the data available, there was no significant difference in the value of shares no. 3 and no. 5 from the standpoint of draft. However, all 16 values except two were below a value of 300 lb and of the two one exceeded that value by 1 lb and the other by 4 lb. Of the eight tests on share no. 1, all were above 300 lb except two, one being 299 lb and the other 286 lb. A study of these data shows that no. 1 share, when new, required significantly higher draft than the other two designs. However, after the shares were worn, there was no significant difference. Dynamometer tests on the model apparatus also showed that a bevel on the share edge gave significantly higher draft, as well as an increased tendency for adhesion or sticking.

Summary

A study of the basic effects of variations in plow share design on the total draft of the plow with special attention to the adhesion of sticky soils shows that the cutting edge of the share exerts material effect on the entire behavior of the plow. Any beveling or increase of approach angle for the surface at the edge of the share affects the soil movement and exerts an increased pressure on the soil which in turn increases draft and deflects soil moving over the share and moldboard, materially affecting scouring. A worn plow share vectored pressure downward with an increased tendency to produce a compact plow sole.

References

1 Nichols, M. L. and Reed, I. F. The dynamic properties of soil, VI.—Physical reactions of soils to moldboard surface. AGRICULTURAL ENGINEERING 15: 187-190, June, 1934.

2 Soehne, W. Einige grundlagen fur eine landtechnische bodenmechanik. Grdlgn. d. Landtechn, Heft 7, 1956.

Soil Reaction: To Subsoiling Equipment

M. L. Nichols
Life Fellow ASAE

C. A. Reaves
Member ASAE

Field and laboratory studies on a wide range of subsoiler types reveal important design information regarding soil shattering and draft requirements

SINCE 1953 the National Tillage Machinery Laboratory has spent much time in the study of subsoiling and subsoiling equipment. In these studies it is concerned with tillage tools designed to open up dense or impervious layers of soil for root penetration. These layers are commonly formed by pressure or puddling below the normal depth of cultivation. Tillage operations of this kind observed by the authors usually involve loosening the soil from the common plow depth of 6 to 8 in. to twice these depths. However subsoiling to the depth of 2 ft is not uncommon. A wide range of designs of subsoilers and subsurface tillage equipment has been studied on all of the 10 soils in the bins at the Laboratory and also on several soils in the field. Soil reactions to different elements of design have been analyzed on the model-test apparatus under conditions where close observations of soil reaction could be made. It is understood that much remains to be done in determining the relationship of design to specific soils varying in physical qualities and conditions, particularly the relationship of depth of subsoiling to power required and the effectiveness and permanency of opening of dense layers to root penetration. However, it is felt that these studies have progressed to the point where we understand what happens before various designs, enough of why it happens, and the magnitude of forces involved to make a practical appraisal of some important features of design and use.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors — M. L. NICHOLS and C. A. REAVES — are, respectively, former director and agricultural engineer, National Tillage Machinery Laboratory (AERD, ARS), U.S. Department of Agriculture, Auburn, Ala.

Moisture Content of Soil

In any subsoiling operation its effectiveness and permanency depends in large part upon the moisture conditions in the soil (1).* Unfortunately, in soil which needs subsoiling, there is frequently a variation of moisture at different depths because of dense layers. Therefore, examination must be made throughout the entire depth affected to appraise probable results. A quick appraisal of conditions can be made by determining if the soil is sufficiently moist to form a small ball and if it is sufficiently plastic to roll out like a wire. If the soil is this moist, it will flow plastically around the tool compacting instead of shattering. In general, this plastic reaction is considered to be detrimental to the

*Numbers in parentheses refer to the appended references.

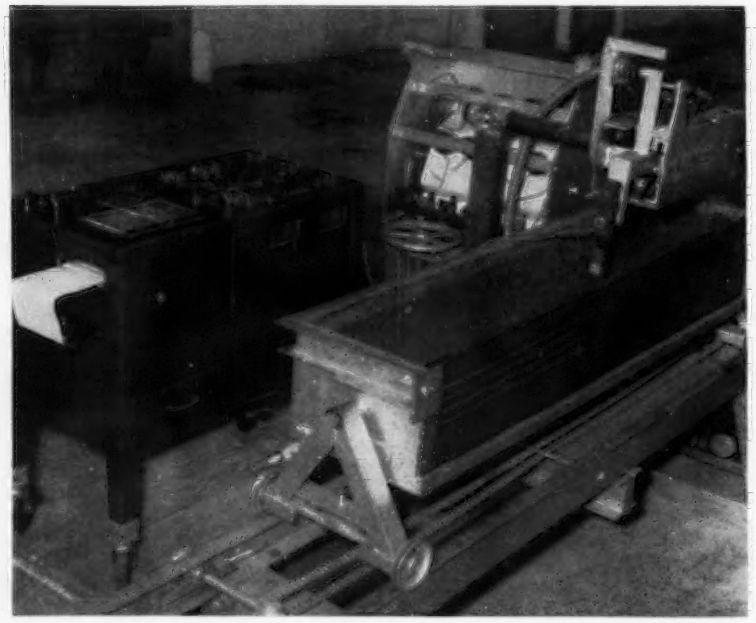


Fig. 1 Model test apparatus. Soil box is 60 in. long, has a glass in one side, and is propelled by a variable speed motor. The tool being tested is suspended in six hydraulic cells whose pressures are recorded continuously. Six strain-gage pressure cells are in the face of the tool

Fig. 2 Reaction of Lloyd clay before a straight vertical chisel. Strings are facial tissue wetted, rolled, and pressed lightly into surface of soil

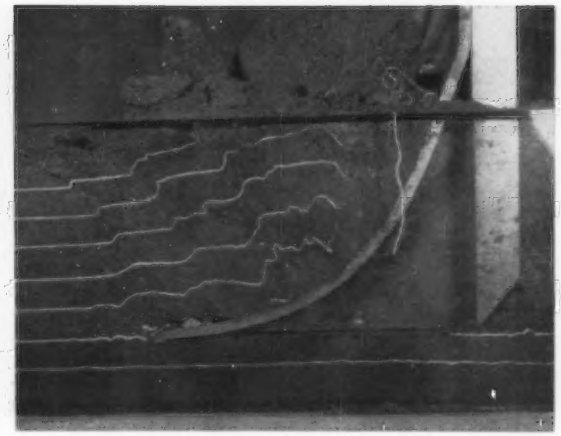


Fig. 3 An experimental point designed from data from soil cones in glass-sided box. Draft was reduced approximately 25 percent

soil and experience indicates that in this case the subsoiling operation is not likely to show beneficial results. However, as will be subsequently explained, small portions or layers may be plastic and puddled without serious detriment if the shattering from the tool extends through sufficiently large portions of the soil to improve aeration and infiltration. Many of the heavier soils, particularly those with a high percentage of montmorillonite, shrink on drying. When dry enough to subsoil, this type is already under great stress and if shattered by subsoiling it breaks into lumps whose shape and size depends largely on these drying stresses. Therefore, the design of the subsoil tool has little effect. In the better agricultural soils, which normally are somewhat friable, the shattering may extend through a large portion of the soil with beneficial results.

Testing Procedure

In order to determine what the soil reaction was to various designs of subsurface tillage tools, a special setup, Fig. 1, was designed for the model test apparatus. In this setup the tool was run beside a glass side of the soil box so that the soil reaction could be observed and photographed. Studies were made of the reaction of various soils to elements of tool design under different moistures and densities. Fig. 2 shows a typical reaction of a soil before an advancing straight vertical chisel running 6 in. deep in a sandy loam soil. The white lines are strings, made by rolling moist facial tissue, which were pressed lightly into the soil surface.

It was noted that as the implement advances the pressure on the soil increases until the soil "buckles up," moving upward which is the direction of least resistance. This buckling occurs at the point of maximum resistance of the confined soil to pressure. As the chisel continues to advance, a portion of the soil (A, Fig. 2) moves forward with the chisel and in effect becomes part of it, acting as a wedge. The soil flows up and over the wedge to the surface. This same reaction has been studied by P. C. J. Payne with particular attention to the forces involved (2). Examination of the soil, within the glass-sided box and comparison with soil wedges or cones found before the chisel in unconfined soil, showed that the observed effect was similar to that which went on at the center of a chisel twice as wide as the one beside the glass in the box. It will be noted that as the chisel and cone advance and the soil flows up over the cone, the vertical pressure or weight of the soil decreases towards the surface while the horizontal pressure continues. As a result, when the soil is dry enough to shatter, shear or rupture planes develop, usually at an angle of 40 to 45 deg and depending on the pressure of the chisel above the cone. When moisture is sufficiently high, the lower part of the cone may develop enough pressure to compress the soil forward and to the side with plastic flow, while nearer the surface the soil at a lower confining pressure will shatter or rupture.

Cone Forms on Point

It has been pointed out that as the soil moves up the cone, it flows over soil. The friction of this is quite high compared with sliding over smooth metal. Studies of the shapes of the cones indicate that the proper form of the

Fig. 4 Part of a cone of soil formed on a subsoiler in a moist clay

Fig. 5 Experimental subsoilers. From left to right, Caterpillar straight, Caterpillar curved, and Rome curved, each with a 3¼-in. point

curve should be exponential, that is, of the general form $y=ae^{bz}$. A metal point (Fig. 3) of this nature was constructed to conform with data from the cones shown in Fig. 2. Tests with this tool gave a reduction of draft of about 25 percent. In studies of the cone it was found that its dimensions depend upon the relationship of soil properties to chisel dimensions. Observations of the reaction of soil before various tool designs showed that the cone increased in its maximum horizontal dimension as the width and depth of the chisel was increased. If the soil was sufficiently moist to adhere to the metal and to compact readily, the cone increased in size over that formed in a dryer soil. In Fig. 4 a large lump of densely packed soil is shown sitting on the point of a heavy duty subsoiler. The looser soil between it and the standard has been removed but the lump shown was supported in place by soil held by the standard. This cone of soil was formed on the point of a subsoiler on one side of the field and was carried across the field and remained attached when the subsoiler was lifted. In this case the moist plastic cone supported by the standard was densely packed and adhered to the point while moving through a compressible plastic layer of the field soil forming a channel, but at the same time it shattered the dryer surface soil to a depth of 14 to 16 in. The operation showed definite beneficial effects on the following crop. In other cases where the soil was packed to a high density and was in normal plowing moisture condition, the soil broke out from the point of the chisel. Examination of cross sections of a number of subsoiler furrows showed good pulverization under these conditions. The vertical angle of the face of the subsoiler standard with the horizontal line of movement is important. This angle affects the cone shape or dimensions by modifying the pressure. In a moist adhesive soil where the chisel was slightly inclined upward and the pressure was high, there was in some cases a slow movement of the cone up the chisel but the cone was constantly maintained by addition of new soil. Payne and Fountaine have explained the mechanism of this reaction (3). Some designers of subsoilers have claimed a material reduction of draft by an angle in the neighborhood of 15 deg. It would appear from this observation of movement up the inclined standard and some draft tests that such a reduction is possible under certain soil conditions.

Draft Factors

The general principle of reaction deduced from these studies of the movement of soil before a surface applying pressure is that a soil uncemented by drying and free to move before force applied which exceeds its strength, as is the case in normal tillage operations, arranges itself by compaction, plastic flow, or the formation of rupture planes in such a manner as to give maximum relief from this pressure with least expenditure of energy and movement is in the direction of least resistance. In general, we may expect fragmentation and rupture of soil in tillable moisture if the resistance to compression is greater than the shear value. These strength values which govern draft for any particular soil depend upon a group of interrelated variables such as moisture, density, degree of confinement or depth, adhesion and coefficient of friction on the tool, cohesion of the soil, coefficient of internal friction, and moment of inertia. We may expect plastic flow if we have a high moisture content that results in a low coefficient of internal friction or where a soil is sufficiently compactible to compress sufficiently to permit passage of the subsoiler without forming rupture planes to the surface.

Buckling Pressure of Chisel

The studies of subsoilers included observations of soil reaction and draft measurements of a number of existing

Fig. 6 Botha subsoiler

designs of subsurface tillage equipment in a number of soils in the bins and in the field. The observations of soil reaction to subsoilers in the bins and field did not contribute much to our knowledge of what was happening in the soil or why it happened until the chisel studies in the model bin revealed something of the nature of the reaction of soil to simple tools such as the chisel. When it was found that the resistance to forward movement of the subsoiler was largely due to the buckling pressure of the chisel standard and that the soil formed a cone which materially reduced the buckling pressure and formed a new flow line of less resistance, the way was opened for experimental design by the testing of deductions from laboratory observations.

Draft Factors

The bin and field studies to date have been concerned with the principal elements of design of the common subsoiler which consists essentially of a standard to which is attached some type of opener, usually a "chisel" or "shovel." This opener may be a simple point similar to a cultivator shovel or it may have horizontal blades or shares on each side of the point attached to produce a sweeplike lifting or shattering of the soil. For either type of subsoil tiller, mechanical strength is an important consideration of design since the implement operates underground where roots and rocks impose very high impact loads. The heavy impact from roots and rocks may be absorbed by shear pins or heavy spring trips but such factors of design have not been studied since the present work has been largely limited to soil implement relationships.

It was found that the relationship of the upward pressure applied by the point of the subsoiler to the horizontal pressure applied to the soil by the standard was very important to draft. Previous work (4) shows that the shear value of the soil, a major factor in the subsoiling operation, is directly proportional to the pressures applied.

TABLE 1 — DRAFT IN POUNDS AT 1½ MPH

Soil	Hiwassee	Davidson	Decatur	Sharkey	Hurricane	Houston
Depth, inches	12.50	12.25	12.00	11.50	11.75	9.5
Curved standard	890	860	1415	1820	1820	1660
Straight standard	960	930	1825	2000	2120	2040

Table 1 shows the comparative draft of two light subsoilers alike in all principal features, except that in the curved standard the point of the subsoiler was sufficiently far ahead of the standard that the effective pressure of the subsoiler was upward from its point while on the straight standard the pressure of the standard itself on the soil was a major factor of the draft. In another replicated group of comparative tests of the effect of pressures of standard on the reaction of heavy Vaiden clay, the standard which was curved so as to reduce horizontal pressure on the soil, required 2200 lb pull, the straight standard angled at 15 deg with the vertical 2690 lb and the vertical standard 3050 lb. With these tests the question arose as to how much curve was necessary to relieve the pressure on the point. Fig. 5 shows three heavy-duty experimental subsoilers varying in curvature.

In the heavy Hurricane soil the straight standard running 14 in. deep and tested at ½ mph required a pull of 2790 lb, the slightly curved standard 2340 lb, and the fully curved standard 2315 lb. It was observed under certain soil conditions that the cone of soil formed by the point of the curved standard flowed up the standard and was left on the surface. Such a "plow" (Fig. 6) was designed in South Africa and called the Botha experimental subsoiler. We were informed that this tool was extensively used in that territory to bring some subsoil to the surface with each plowing.

The question of breaking up dense layers rather completely with wide sweeps instead of breaking channels through them with subsoilers is one which must be considered. The Laboratory has run a number of tests of different designs of sweeps at depths approximately double that of ordinary tillage. With Lakeland sand, a 55-in. sweep pulled 1600 lb when running 11 in. deep at 1 mph, while in Hiwassee sandy loam, a type of soil where impervious layers frequently form, the draft was 3800 lb at 12 in. deep. In the Davidson clay the draft of this large sweep when running 12 in. deep varied from 4380 with no coulter to 4930 with a coulter. The draft of a 40-in. sweep 12 in. deep was 2560 lb in the Hiwassee sandy loam and 2920 lb in the Davidson clay loam. In very heavy Vaiden clay, the 40-in. sweep 12 in. deep pulled over 9000 lb, while an 18-in. sweep pulled 3970 lb at 12½ in. deep and 5540 lb at 13½ in. depth. From these data, it would appear that such complete fragmentation would only be economically justified in exceptional conditions.

Summary

At the National Tillage Machinery Laboratory a wide range of designs of subsoilers have been studied in the soil bins of the Laboratory and their use has been observed in the field. These studies have been supplemented in the Laboratory with equipment specially designed to study subsurface reaction before different designs to determine how various features of design affect soil reactions and something of the "why" of the reaction. This apparatus and method of use is described with observation of the interaction of soil and implement. A general principle of reaction of soil to force application is advanced. The effects of soil moisture are pointed out and a quick field method of evaluating critical conditions suggested. Since it appeared that the effectiveness of subsoiling depended in part at least upon the shattering of the soil, particular attention was given to factors affecting this reaction.

From the combination of bin and field tests and laboratory observation of reactions, it was found that a major factor in power requirement is the horizontal pressure of the standard against the soil which materially increases the force required for shear or fragmentation (1). Data from experimental subsoilers designed to relieve this pressure are included.

References

1 Nichols, M. L. and Reaves, C. A. Soil structure and consistency in tillage implement design. AGRICULTURAL ENGINEERING, vol. 36, no. 8, pp 517-520, 522, August, 1955.

2 Payne, P. C. J. The relationship between the mechanical properties of soil and the performance of simple cultivation implements. Jour. Agr. Eng. Research 1:23-50, 1956.

3 Payne, P. C. J. and Fountaine, E. R. The mechanism of scouring for cultivation implements. Technical Memorandum 116 —National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

4 Nichols, M. L. The dynamic properties of soil III. The shear value of uncemented soil. AGRICULTURAL ENGINEERING, vol. 13, no. 8, August, 1932.

What are the chances of a 20-year 1-hour rainfall this August? The answer can be found in . . .

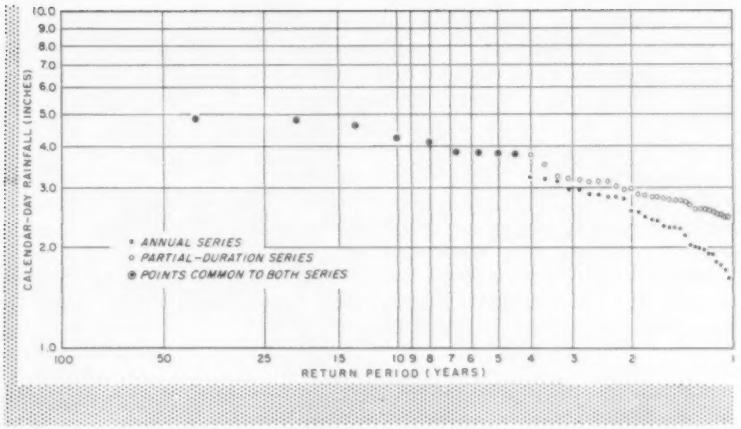


Fig. 1 — Rainfall frequency data, Charlotte, North Carolina (1902-1940). Example of annual and partial-duration series extreme-value rainfall data

Frequency Analysis of Rainfall Intensity Data

W. T. Wilson
and
D. M. Hershfield

SOIL Conservation Service engineers, in the new *Watershed Protection and Flood Prevention* program, need frequencies not only for point rainfall, but for areas up to 400 square miles. In addition, they need to know seasonal variation and other characteristics of the rainfall intensity regime. This paper describes the Weather Bureau's work along these lines for a program sponsored by the Soil Conservation Service.

One of the products of this rainfall intensity-frequency work, Weather Bureau Technical Paper No. 25(1)*, is a set of curves for each of about 200 stations at important United States cities. These give the rainfall regime for durations of 5 min to 24 hr for return periods of 2 to 100 years. For the entire region west of the 105th meridian—about Denver—this information has been generalized. Maps and diagrams give rainfall estimates for any point in the West. This material has been published as Weather Bureau Technical Paper No. 28(2).

Weather Stations

The data going into Technical Paper No. 28 come from the following types of stations:

50 first-order stations, all durations, long records
700 recorder stations, all durations, 15 years of record
2000 non-recorders, daily totals, moderate to long records

Paper presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Michigan, June, 1957—revised July 3 and December 23, 1957.

The authors — W. T. WILSON and D. M. HERSHFIELD — are, respectively, hydrologist and meteorologist, U. S. Weather Bureau, Washington, D. C.

*Numbers in parentheses refer to the appended references.

Each kind of data is exploited by means of relationships based on the data from these 50 first-order stations—and frequently from additional stations. By developing a relationship between 24-hr rainfall and that for shorter durations, analysts fill gaps in the isopluvial maps with data from many stations that report only the daily total. By using relationships for short-duration rainfall between long and short return periods, data from the 700 short-record recorders augment the other short-duration frequency data. These two types of relationships—one of duration and one of frequency — are used because they have less sampling error and vary less over a region than rainfall amounts themselves.

Data Processing

The form in which data are available is an important element in processing the data. An array of the highest N or more values in a period of N years is known as a partial, or partial-duration series. But this series is laborious to compile. It is more economical and convenient to work with the annual series — an array of the extreme value for each year of record. The main objection to the annual series is that the highest value for some particular year may be exceeded by the second or third highest of some other year. It thereby omits some of the high values and may result in systematic under-design.

This observed systematic bias conforms closely to a set of values that are used in transforming annual-series data to partial-series results. As shown in Fig. 1, most of the difference between the two series is at the lower values. Average transformation factors are 1.13 at two years, 1.04 at five years, and 1.01 at ten years. For longer return periods no adjustment is made because the two series use nearly the same data. The partial series curve, usually defined subjectively, is poor when the record is short. As an illustration

of the high correlation of these empirical factors, Fig. 2 shows partial-series data plotted against annual-series data multiplied by the factor 1.11. The return period is 2.3 years, corresponding to the mean of the annual series. There were sufficient data to insure good definition of the 2.3-year values, regardless of the method of analysis.

Clock-Hour vs. Maximum 60 Minutes

It is necessary to distinguish between clock-hour and maximum 60-min rainfall. Clock-hour rainfall is published and readily available. However, the rain occurring during the clock-hour may occur in only part of the hour. Possibly total rain occurring in two successive clock hours may fall in a short time interval that overlaps the two clock hours. Of course, the structure that has to handle the runoff is influenced by the maximum successive n-minute rainfall, rather than what happened to occur during an arbitrary time period.

We found it necessary to derive empirical transformations between maximum n-minute rainfall and the rainfall for arbitrary periods such as clock-hour, calendar-day, etc. To do this, two series were compiled and analyzed for a common period of record for each of several stations, and for each of several durations. For example, one series included the maximum clock-hour rainfall for each year of record. The comparison series included the maximum rainfall in any successive 60 min for each year of record. The maximum 60-min and the maximum clock-hour values did not necessarily come from the same storm. For each station the means of the two series were plotted against each other.

Fig. 3 shows the means of the two series plotted against each other for each of many stations for 60-min durations. Similar figures have been prepared for other durations, comparing maximum 1440-min rainfall with calendar-day rainfall, etc. Fig. 3, showing a typical scatter, illustrates the 1.13 factor applied to clock-hour to obtain maximum 60-min rainfall.

Smoothing of Maps

A fundamental problem in generalizing is how much smoothing to do. In drawing isopluvials (isolines of rainfall frequency), should the lines be drawn, very irregularly if necessary, so as to recognize every point as being perfectly valid? Or should the lines be smoothed to some degree, with obvious departures from some of the points? And for what points should the departures be greatest or least?

In studying data from areas where there is no orographic or other assignable cause for departures from a group average of, say a 2-year, one-hour rainfall, a standard deviation of 20 percent of the mean value for the group of stations usually exists. We believe this dispersion of values is mostly sampling error — the chance occurrence of storms hitting some stations and not others.

The standard deviation is a measure of how much smoothing is appropriate. But how to weigh the data from different stations? We know that the longer records are best. Data from stations having continuous professional attendance are naturally better.

The map may be drawn as if it were to represent the contours of a warped surface. The standard error of estimate from this surface should be commensurate with the standard deviation of the data taken from selected groups of stations. These groups must have no orographic influence and must cover too small a region for an average climatic gradient to be a factor.

Orographic Effects

In mountainous regions, an assignable cause, orography, may add considerably to the random variation in precipitation over small areas. Many have tried to express orographic influences in terms of objectively defined parameters such as elevation, orientation, convexity or concavity of local site, local slope, distance from ridge or ocean, etc. (3, 4). These parameters have been notably successful in work with mean seasonal or mean annual precipitation. Mean annual precipitation is the composite of a large mass of data. Influence of wind, for example, is averaged out.

With short-duration rainfall, however, such parameters have not been so useful. During the 50 or fewer hours of actual rainfall that make up the 50-year record of yearly

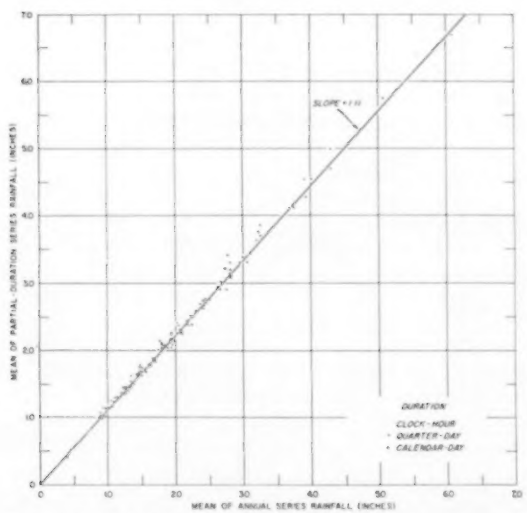


Fig. 2 Relation between partial-duration and annual series rainfall

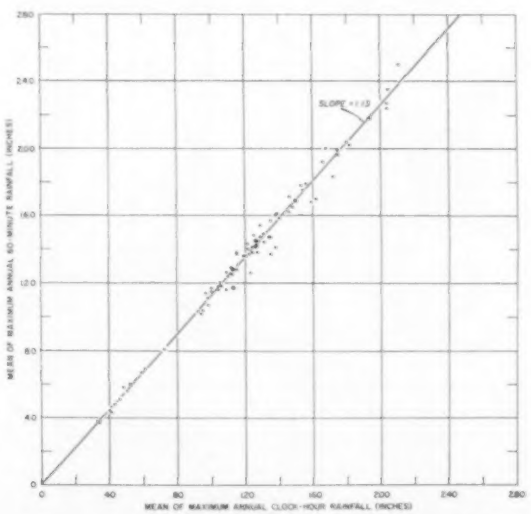


Fig. 3 Relation between 60-minute and clock-hour rainfall

maximum hourly rainfall at a given station, wind speed and direction may have been too variable for an average effect on gage catch to have much meaning. Wind and other variables tend to obscure the unchanging physiographic parameters.

Any success achieved by relating short duration rainfall-frequency data to physiographic parameters has relied heavily on extensive zoning. Excessive zoning, particularly with short-record data, must use so many degrees of freedom that it is difficult to assess the result. Further, it is rarely possible to transpose relationships that depend on unique zones to regions very far from where they were derived.

The problem still remains of drawing isopluvial lines in regions where orographic effects exist, and where they are hard to define. Except for a subjective tendency to increase the short-duration rainfall intensity values slightly with elevation, the same interpolation and smoothing procedures that are used in plains regions may give the best results.

Much as one wishes to display a good relationship, there is an obligation to describe the precipitation regime only as well as the data permit. Part of the obligation is the evalua-

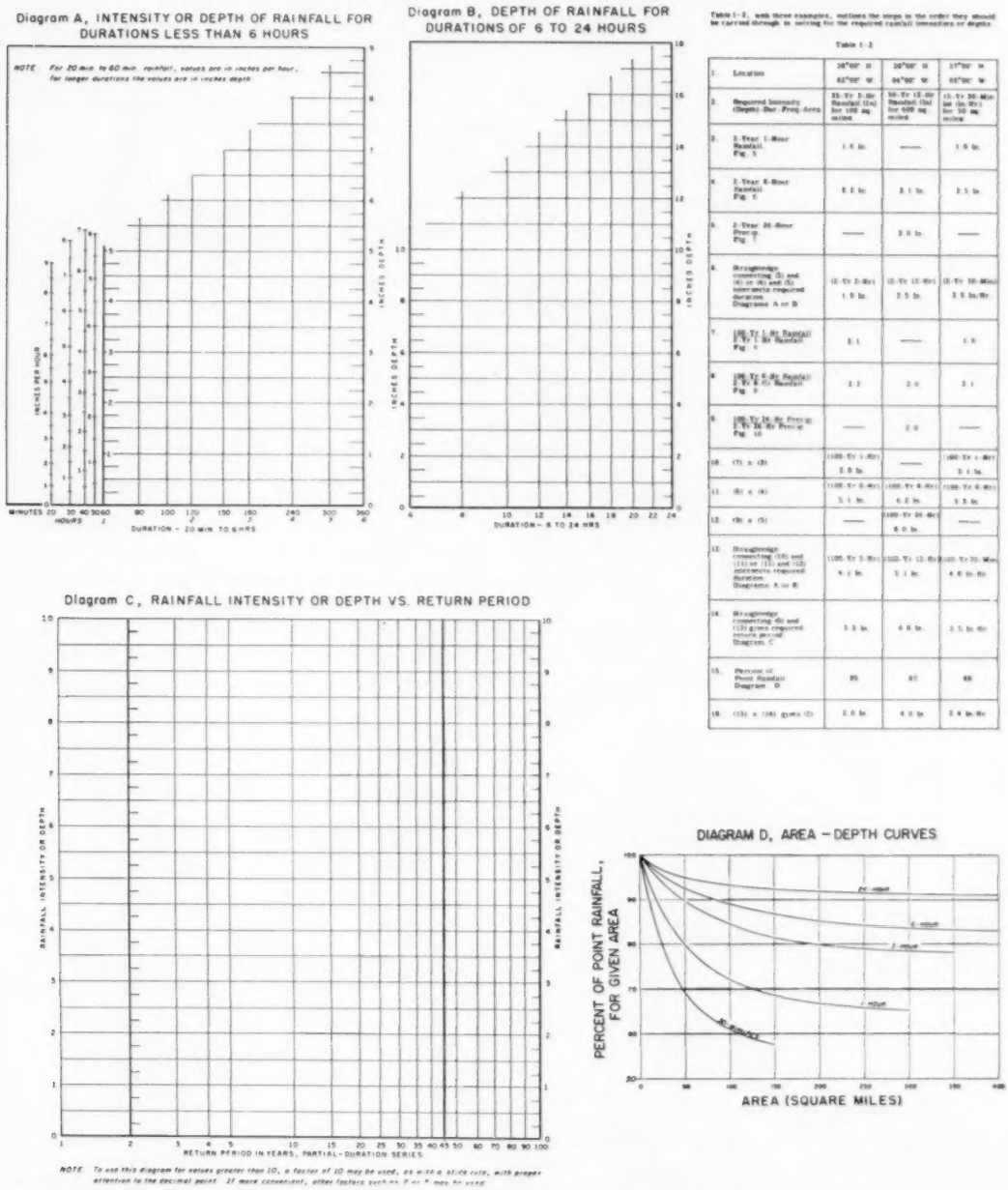


Diagram A, INTENSITY OR DEPTH OF RAINFALL FOR DURATIONS LESS THAN 6 HOURS
Diagram B, DEPTH OF RAINFALL FOR DURATIONS OF 6 TO 24 HOURS
Diagram C, RAINFALL INTENSITY OR DEPTH VS. RETURN PERIOD
RETURN PERIOD IN YEARS, PARTIAL-DURATION SERIES
DIAGRAM D, AREA – DEPTH CURVES
PERCENT OF POINT RAINFALL, FOR GIVEN AREA
AREA (SQUARE MILES)

Fig. 4 Duration, frequency, area-depth diagrams, and examples of computation for weather bureau technical Paper No. 29, Part 1 (Prepared March, 1957)

tion of the generalized relationships, including the isopluvial maps. Instead of having probable error of the magnitude of 20 percent of the mean, the probable error may be as high as 50 percent in rugged regions of sparse data.

Evaluation of Station Sites

Some stations are better exposed than others, and exposure influences the catch. Also, exposure of a gage may change during its period of record. For mean annual precipitation, gage exposure, type of gage, observational methods, and similar variables are calculated by double-mass, analysis. No such method applies to short-duration data—for much the same reason that physiographic parameters have limited effectiveness. Wind speed, direction, and other variables do not balance out with the small number of data involved. Accordingly, the variation in gage exposure is regarded as a random variable. Its effects are included in the smoothing of the maps. Any bias would be the slight average bias caused by the gages' tendency to catch a little less—rather than a little more — than they should. This bias is included, usually implicitly, in most rainfall relationships.

Graphical Portrayal

Rainfall intensity-frequency-duration data until recently was fitted into various kinds of algebraic formulas. One often used is:

$$i = K(T_r)^m / D^n$$

where i is intensity in depth per unit time, T_r is number of years' return period, D is duration in minutes, and K, m and n are empirical constants.

Investigators have made a hobby of advocating and evaluating these formulas. This practice is pointless algebraic exercise because it is easy to portray the data graphically. Graphical portrayal is as precise as the data warrant. It is as easy to plot data of rainfall depth for given depths and return periods as it is to plot values of K, m and n on maps. And it is much easier for the user. Perhaps the worst feature of such formulas is the strain on the formula itself to cover unnecessarily such a wide range of values.

Duration Relationships

Diagrams A and B of Fig. 4 express empirical relationships between rainfall depth (or intensity), and duration. Based on data from 200 first-order Weather Bureau stations, they apply anywhere in the United States. They meet the problem of interpolating between isopluvial lines of the same frequency showing rainfall for varying durations. With a 1-hr and a 6-hr map for the same frequency, values for these two durations can be transferred to Diagram A. A straightedge through these values accurately defines the rainfall intensity or depth for 20 min to 6 hr. Similarly, the 6 and 24-hr values define, in diagram B, the values for all intermediate durations.

Frequency Relationships

Diagram C of Fig. 4 is similar to diagrams A and B. It is based on the same data and applies anywhere in the United States. It is for interpolating among maps having different return periods. By placing a straightedge along the 2-year and 100-year values for any duration, values for other return periods can be read directly. The diagram uses partial-series data.

If the transformations between annual series and partial series are applied for the shorter return periods, and if the resulting values for 2-year and longer return periods are plotted on either Gumbel or log-normal paper, there will be negligible departure from linearity.

Area-Depth Relationships

The Soil Conservation Service needs both point data and average depths for areas up to 400 square miles. Results are given in diagram D of Fig. 4. Methods of deriving the relationships are described in Weather Bureau Technical Paper No. 29, Part 1(5).

To obtain the average depth of rainfall for a given return period, the diagram is entered with the average point value within that area — as determined from a map, or otherwise. The average value is read from the appropriate duration curve — or interpolated among the curves. For long durations the areal value is only slightly less than for the average point in the area. As the figure suggests, duration is the main parameter.

There is considerable scatter of points (not shown) about these lines. Efforts were made to evaluate additional parameters so as to reduce the scatter. Storm magnitude (or return period) was found to have negligible influence. No regional influence was found. Too few dense networks of

(Continued on page 353)

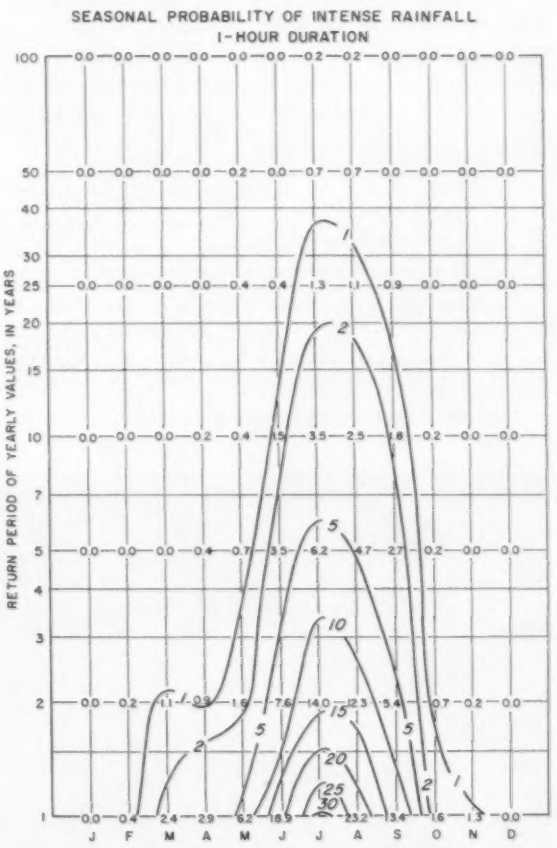


Fig. 5 Probability in percent of obtaining a rainfall in any month of a particular year equal to or exceeding the yearly return period values taken from the isopluvial maps and diagrams

Lateral Duct Air Flow Patterns in Grain Drying Bins

D. B. Brooker
Member ASAE

Air flow studies offer objective comparison of four types of lateral ducts for introducing air into bins during "in-storage" grain drying

DUCT systems are now popular for introducing air into the grain in in-storage grain drying systems. Such systems consist of three elements: the fan to move the air through the grain, the bin, and the device to bring the air into the grain mass. Usually a main duct, serving as a plenum chamber, carries the air from the fan to the lateral ducts. These ducts deliver the air into the grain mass.

Air flow from lateral ducts has been termed *nonlinear* in contrast to parallel or *linear* flow. The term linear indicates that the air travels in parallel paths and with uniform velocity through the grain mass.

Air leaving a lateral duct will travel in various paths that are dependent on the geometry of the bin and the spacing and geometry of the ducts.

Air Flow Studies

Studies have been under way at the University of Missouri since 1953 to analyze the flow of air from lateral ducts. The tests reported here were conducted to study air flow from four types of lateral ducts. Factors investigated were:

(a) Total air flow versus static pressure for any chosen length of duct

(b) Air distribution in the bin

(c) Effect of duct pressure on air distribution.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1957, on a joint program arranged by the Electric Power and Processing and Farm Structures Divisions. Approved for publication by the director of the Missouri Agricultural Experiment Station as Journal Series No. 1818.

The author—D. B. BROOKER—is associate professor of agricultural engineering at the University of Missouri, Columbia.

Test Bin Described

The test bin (Fig. 1) had a floor area of 4 ft by 8 ft and a height of 8 ft. The bin was filled with wheat. The geometry and the spacing of the ducts can be determined by examining Figs. 4, 5, 6, and 7. The bin cross section shown in these figures is for a 4-ft width of bin served by the lateral or laterals shown. Two such sections made up the test bin, but since they are identical, only one is shown. The lateral ducts were placed across the short dimension of the bin and were 4 ft in length. They received air from a plenum or main duct extending along the outside of the bin. Sliding doors at the end of each lateral made it possible to adjust air flow so that the static pressure was the same in the various laterals during each test.

Air flow was measured with a thermal meter that was constructed as a Thomas flow meter (6).* Flow was measured by adding a known amount of heat to the air and measuring the resultant temperature rise. The meter used (Fig. 2) measured the temperature rise by means of a thermopile. The wiring pattern for the instrument is that devised by Hinkle (2) in constructing similar meters.

Air distribution was analyzed in the same manner as that described by Hukill and Shedd (3) in an unpublished paper concerning the drying of oats in a bin with non-linear air flow.

Pressure Readings

The first step in determining the air distribution was to measure the pressure in the grain mass at numerous points

*Numbers in parentheses refer to the appended references.

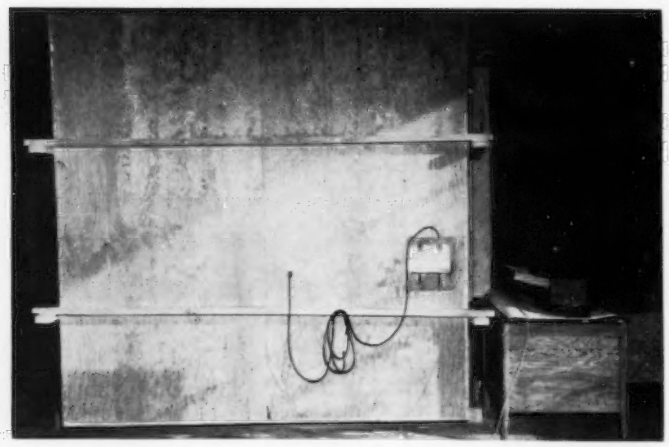


Fig. 1 The test bin with the pressure sensing probe in position to take a pressure reading. The hook gage is mounted on the bin wall. The fan and air flow measuring equipment is at the right

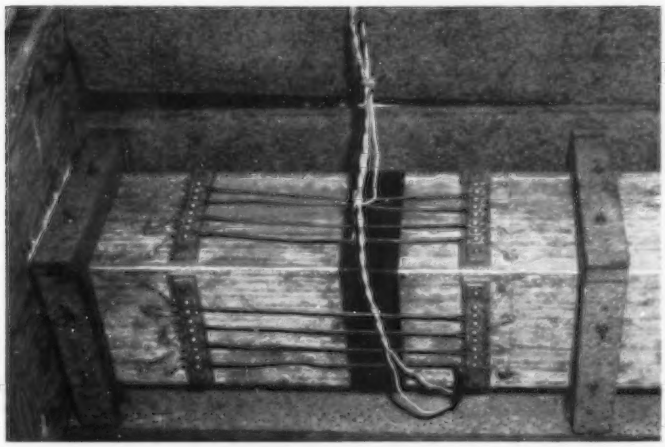


Fig. 2 An external view of the air flow meter showing thermocouple lead-in wires and electrical connections

in the cross section. Pressure readings were taken on a grid pattern with a smaller grid used at the bottom of the bin near the duct. A typical pressure pattern is shown in Fig. 3. The iso-pressure lines have also been drawn in Fig. 3.

The pressure was measured by inserting a small diameter probe through the bin wall and into the grain mass a distance of approximately 8 in. The probe was hollow and had several small holes drilled in it near the tip. Holes were drilled in the bin wall to form the grid for the pressure measurements. These holes were sealed with masking tape that was removed at a particular hole only while the pressure reading was taken at that point.

The probe was fitted with a rubber gasket to prevent air from escaping from the hole when the probe was inserted. The probe was connected to a hook gage manometer that used a micrometer to measure water level.

After the pressure pattern had been determined and the isopressure lines drawn, a number of air flow lines were drawn on the premise that the direction of air flow is perpendicular to the isopressure lines.

Analyzing Air Flow

The analysis of air flow along an air flow line (again after the method of Hukill and Shedd), was accomplished by assuming a rate of air flow along the line. If one cubic foot per minute is assumed, the calculations are simplified. To further simplify the computations, the amount of grain considered is that contained in a slab 1 ft thick in a plane at right angles to the duct. In passing from one isopressure line to the next, the air must maintain some average velocity that corresponds to the pressure change over the distance between the lines. The relation of velocity to pressure change per unit distance used in the computations are those determined by Shedd (5).

When the path of the air and its velocity have been determined, it is possible to determine the width (W) of the path to which one cfm must necessarily be confined for the air to maintain the known velocity.

$$V=Q/A=1/(1\times W)=1/W \text{ or } W=1/V$$

Where: V is apparent velocity (fpm) from Shedd's data (5)

Q is one cfm

A is average cross-sectional area (sq ft) through which the one cfm of air passes in traveling between the chosen isopressure lines. ($A=W\times 1$ because the slab of grain has been chosen as one foot thick)

The volume of grain through which the one cfm of air passes in the distance between the isopressure lines is:

$$\text{Volume}=W\times 1\times X=X/V$$

Where X is distance between the isopressure lines in feet.

The volume can be converted to bushels by multiplying by 0.8.

Finding cfm per Bushel

Calculations are begun at the duct. The bushels of grain that one cfm passes through along the flow line are determined for chosen increments of pressure change. Summing these figures from the point where the air leaves the duct to any point along the flow line will give the number of bushels of grain through which the one cfm has passed to reach the chosen point. If the reciprocal of this figure is taken, the units would properly become cfm per bushel.

Nomenclature has not been established for the reciprocal figure mentioned. The term cfm per bushel has become widely accepted to mean the total cubic feet of air delivered to the bin divided by the number of bushels of grain in the bin. Hall(1) has used the term *cfm per accumulated bushel* to describe the figure.

Hukill and Shedd (4), taking a different approach, have computed the time it takes the air to travel from the duct to the point and have called this *traverse time*. The time is expressed in seconds.

Either term is a means of expressing the comparative time required to dry the grain at any particular point in the bin. Figs. 4, 5, 6, and 7 use the *cfm per bushel* designation — the same as Hall's *cfm per accumulated bushel* expression.

Figs. 4, 5, 6, and 7 give the *cfm per bushel* pattern for the four ducts when the static pressure in the ducts is approximately 2.0 in. of water. In each case the last part of the bin to dry will be the grain at the surface midway between the ducts. The lines of constant *cfm per bushel* represent the shape of the drying front as it passes from the duct to the bin surface.

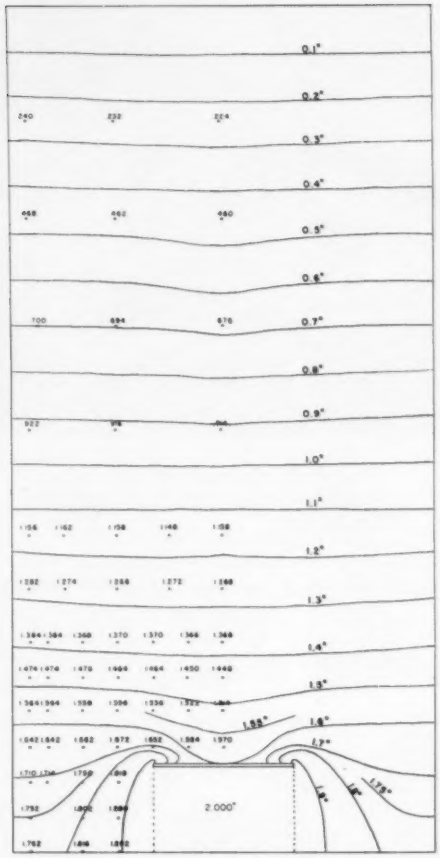


Fig.3 A pressure pattern taken when the pressure in one of the ducts was 2.0 inches. Isopressure lines have been drawn. Pressure is measured in inches of water

. . . Air Flow Patterns

A few years ago a bin equipped with the duct shown in Fig. 6 was used to dry grain sorghum at the University of Missouri. The air flow rate was inadequate and a mold pattern developed identical in shape to that which would be predicted by a study of Fig. 6.

Minimum Ventilation Rates

Several pressure patterns were taken for each duct using a different duct pressure each time. For each pattern the flow rate was analyzed along the flow line that leaves the grain at the surface midway between the ducts. The *cfm per bushel* at the surface (at the end of this flow line) was considered to be *minimum cfm per bushel* for that particular duct pressure. Fig. 9 plots these *minimum cfm per bushel* figures against static pressure in the duct.

The *cfm per bushel* for grain at the surface of a similar bin equipped with a false floor filled to a depth of 8 ft is also shown. This makes it possible to compare the time required to dry a bin of grain equipped with a duct system to the time required if a false floor is used.

Air Flow Versus Duct Pressure

Fig. 8 is a plot of air flow versus static pressure (system curves) for a bin equipped with the various ducts and filled to a depth of 8 ft with wheat. A bin with a floor area of 24 ft by 40 ft has been chosen.

The flow rate for any particular static pressure does not vary to any great extent between the various duct systems. A system curve for a false floor covered with 8 ft of wheat would pass through the same region of the graph as the other curves passing slightly above them at the lower static pressure. These data prove that the rule of thumb used by many in designing ducts has a good deal of merit when

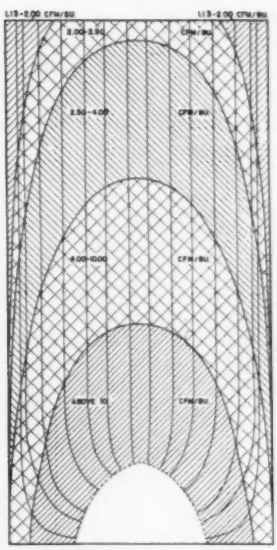


Fig. 4

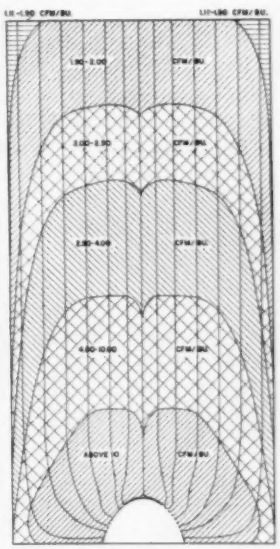


Fig. 5

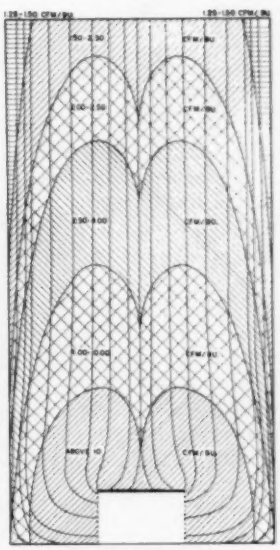


Fig. 6

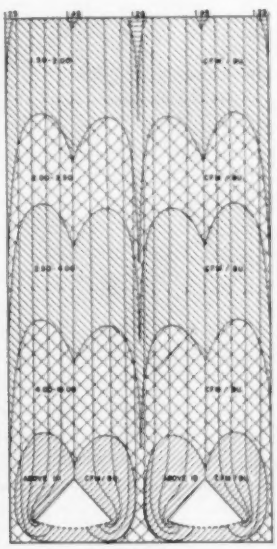


Fig. 7

Fig. 4 Air distribution in the bin when the expanded metal, inverted catenary laterals spaced 4 ft on center were placed in the bin. • Fig. 5 Air distribution in the bin when the semicircular "side opening" laterals spaced 4 ft on center were placed in the bin • Fig. 6 Air distribution in the bin when the rectangular side opening laterals spaced 4 ft on center were placed in the bin • Fig. 7 Air distribution in the bin when the inverted V-laterals spaced 2 ft on center were placed in the bin. The duct pressure in each bin was 2 in. of water

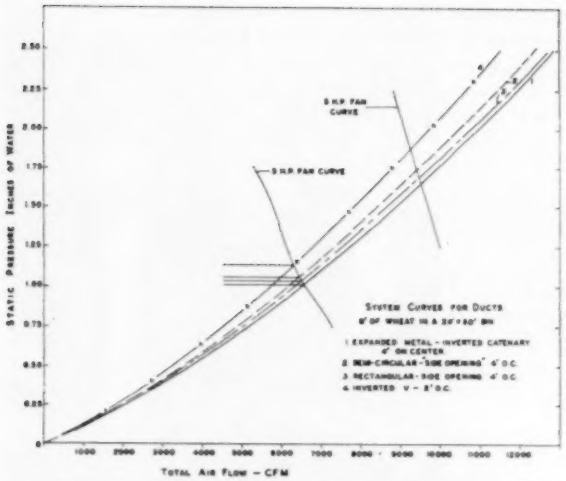

STATIC PRESSURE INCHES OF WATER
TOTAL AIR FLOW – CFM
5 H.P. FAN CURVE
3 H.P. FAN CURVE
SYSTEM CURVES FOR DUCTS
8' OF WHEAT IN A 24' x 40' BIN
1. EXPANDED METAL – INVERTED CATENARY 4' ON CENTER
2. SEMI-CIRCULAR – SIDE OPENING 4' O.C.
3. RECTANGULAR – SIDE OPENING 4' O.C.
4. INVERTED V – 8' O.C.

Fig. 8 The system curves for the various ducts placed in a 24 x 40-ft bin filled to a depth of 8 ft with wheat, plotted against two typical fan performance curves

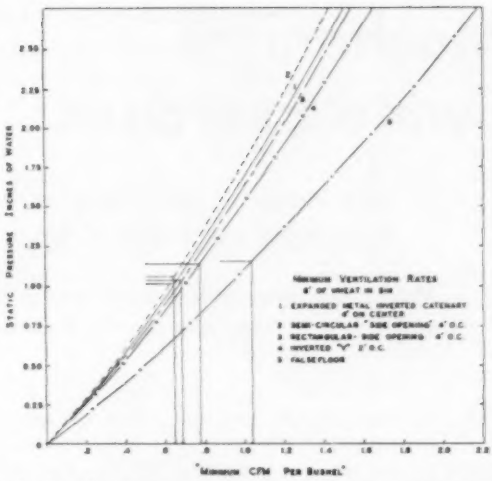

STATIC PRESSURE INCHES OF WATER
MINIMUM VENTILATION RATES
8' OF WHEAT IN BIN
1. EXPANDED METAL INVERTED CATENARY 4' ON CENTER
2. SEMI-CIRCULAR "SIDE OPENING" 4' O.C.
3. RECTANGULAR – SIDE OPENING 4' O.C.
4. INVERTED "V" 8' O.C.
5. FALSE FLOOR
MINIMUM CFM PER BUSHEL

Fig. 9 A plot of minimum ventilation rates against static pressure. The lighter vertical lines indicate the comparative rate of drying expected if the bin of Fig. 8 is equipped with the various ducts or a false floor and the 3-hp fan supplies the air

judgment is based on static pressure and air flow. The rule calls for the *air escape area* (area along the duct periphery where the air can enter the grain) to be at least equal to one-fourth of the floor area. This criteria is met in each of the ducts tested. The small difference between the curves on Fig. 8 appears to be a function of the air escape area.

To compare the drying time required for the various systems using a particular fan, the fan performance curve is plotted on the same graph with the system curve for the bin equipped with the various ducts. Two typical fan curves are plotted on Fig. 8. The points at which the fan curve cuts each system curve indicates the static pressure at which the fan and system are in equilibrium.

The custom has been to read the cfm from the graph at the equilibrium point and divide this figure by the number of bushels of grain in the bin to determine cfm per bushel. This figure is an indication of drying time only if the bin is equipped with a false floor. A more accurate indication of the comparative time required is to enter Fig. 9 with the pressure at which each system will operate.

In the example shown here, the minimum cfm per bushel for the various duct systems does not indicate that any of the four systems has a definite advantage over the others as far as drying time is concerned. The advantage of a false floor is apparent if the false floor is compared to the duct systems purely from a standpoint of drying time.

How to Cut Drying Time

An increase in the minimum cfm per bushel or a decrease in drying time can be brought about by one or a combination of the following methods:

(a) Increasing the pressure in the duct by increasing fan output at any given static pressure

(b) Placing the ducts closer together

(c) Using an air escape area that will give the optimum cfm per bushel at the region of minimum ventilation

Any of these methods have certain physical limitations. More horsepower is required to increase the pressure by increasing total air delivery. In the example bin used for Fig. 8, a 5-hp fan unit will increase the duct pressure enough to give the ducts approximately the same minimum cfm per bushel as that obtained with a false floor and a 3-hp fan.

Moving ducts closer together will increase the drying rate at a point on the surface midway between the ducts. In some duct designs (the duct shown in Fig. 6, for example) this may create a new region of minimum drying rate. With any duct design, closer spacing will increase cost and eliminate some advantages usually associated with duct use.

The third method should be the goal of the designer. Changing the air escape area of a duct will result in a change in air flow characteristics when analyzed as shown in Figs. 8 and 9. Some particular air escape area will give the optimum combination of air flow characteristics for any given set of conditions (bin geometry, duct spacing, etc.).

Taking measurements and using an analytical method previously developed (3) makes possible an objective comparison of four lateral duct types. Comparing the ducts one to another and to a false floor by this method gives a more accurate measure of performance than would a comparison based only on total air flow versus static pressure.

References

1 Hall, Carl W. Analysis of air flow in grain drying, AGRICULTURAL ENGINEERING, Vol. 36, April 1955.

2 Hinkle, Charles N. Effects of selected environmental factors on the absorption of radiation from a 100 F surface by cold plates, unpublished PhD thesis, University of Missouri, 1957.

3 Hukill, W. V. and Shedd, C. K. Ventilation of oats in 16x20 ft quonset buildings, unpublished USDA report, September 1953.

4 Hukill, W. V. and Shedd, C. K. Non-linear air flow in grain drying, AGRICULTURAL ENGINEERING, Vol. 36, July 1955.

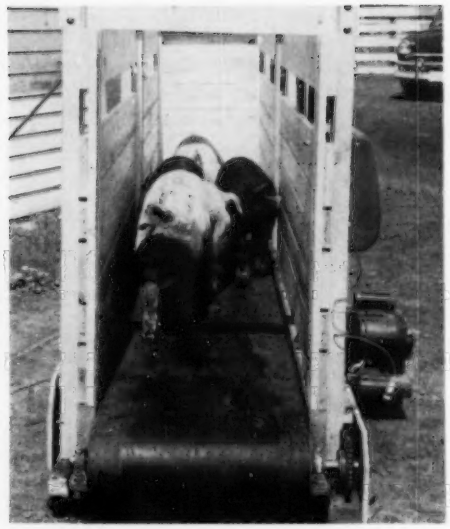
5 Shedd, C. K. Resistance of grain and seeds to air flow, AGRICULTURAL ENGINEERING, Vol. 34, September 1953.

6 Sweeney, R. J. Measurement techniques in mechanical engineering, John Wiley and Sons, Inc., New York, pp. 232-233, 1953.

Mechanical Swine Exerciser

M. F. Finner, E. J. Briskey, R. W. Bray
W. G. Hoekstra, and R. H. Grummer

Mechanical treadmill substitutes for outdoor space in providing exercise for growing hogs



A LIMITED number of methods are described in the literature for experimentally administering forced muscular exercise to cattle. Primarily, these methods encompass animal operated treadmills as described by Woodard (5)*, and Bull *et al* (1), and mechanically operated bull exercisers as originally described by Hamilton and Symington(2).

More recently Vestal(4) provided exercise for hogs by driving them in a narrow lane twice a day. There are no reported techniques or methods for mechanically administering and controlling for experimental purposes the amount of exercise that might be provided to swine.

In view of the need for this technique, a mechanical exerciser was designed and constructed that functions effectively in swine exercising.

Apparatus Design

The apparatus as described herein has been used for exercising hogs ranging in weight from 30 to 290 lb. In an effort to make the apparatus suitable for exercising hogs of various weights, the following dimensions were selected: inside width, 20 in.; inside length, 12 ft and inside height, 38 in. This design permits the exercise of four small hogs (30 to 70 lb) simultaneously by partitioning the pen space.

The belt used on this device is a rubber endless, conveyor belt 20 in. wide. Rollers, 6-in. diam., are mounted on suitable bearings at each end to function as pulleys. The idle roller (Fig. 2) is equipped with a convenient method for adjusting the tension on the belt.

Power Train

Fig. 4 shows the details of the power train from the motor to the belt drive roller. Two counter shafts are required to provide the necessary speed reduction without unduly large sprockets. A stepcone pulley is utilized to effect speed changes rapidly. The following speeds are obtainable with the apparatus as described herein.

Motor pulley O.D. (in.)	Belt speed, mph
2.25	0.68
3.25	1.01
4.25	1.41
5.25	1.77

The theoretical horsepower required for this apparatus can be derived from the basic horsepower formula,

$$\text{Horsepower} = FV/33000$$

F = force in pounds

V = velocity in feet per minute

Paper prepared expressly for AGRICULTURAL ENGINEERING and published with the approval of the director of the Wisconsin Agricultural Experiment Station, Madison.

The authors — M. F. FINNER, E. J. BRISKEY, R. W. BRAY, W. G. HOEKSTRA, and R. H. GRUMMER — are respectively, instructor in agricultural engineering, instructor in animal husbandry, professor in animal husbandry, assistant professor in biochemistry, and professor in animal husbandry, The University of Wisconsin, Madison.

*Numbers in parentheses refer to the appended references.

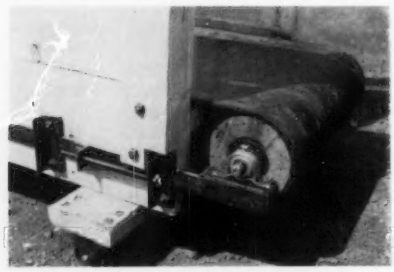


Fig. 2 Idle roller and tension adjuster

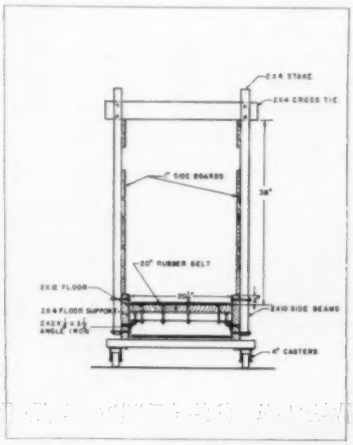


Fig. 3 Cross section of hog exerciser

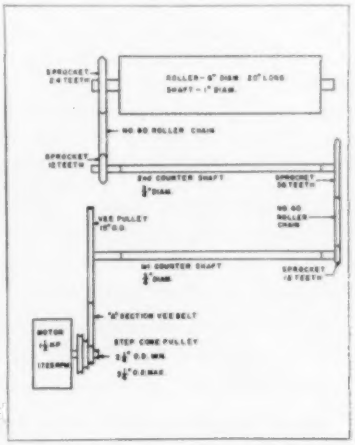


Fig. 4 Power train for hog exerciser

Assuming a coefficient of friction for rubber on wood of 0.7 and 2(200 lb) hogs exercising at 1.5 mph, the horsepower required is 1.12. It is apparent that the horsepower requirement increases directly with the weight of the animals and the speed of exercise. For this reason, a 1.5-hp motor is used which offers flexibility in the use of this apparatus. A mechanical timer is installed for removing the variable of timing errors. An electric fence is used for training small hogs.

References

1 Bull, Sleeter and Rusk, H. P. Effect of exercise on quality of beef, Bulletin 488, University of Illinois, 1941.

2 Hamilton, J. G. and Symington, E. L. Cooperative artificial insemination of dairy cattle, Canadian Journal of Comp. Med., 3:337, 1939.

3 Mitchell, H. H. and Hamilton, T. S. Effect of long-continued muscular exercise upon the chemical composition of the muscles and other tissues of beef cattle. Jour. of Agr. Res., vol. 46, No. 10, 1933.

4 Vestal, C. M. The influence of exercise on the rate and economy of gain of market hogs, Purdue University, Agr. Exp. Station. Mimeo No. 40, 1949.

5 Woodard, E. G. The effect of exercise and feed upon the vitality and breeding ability of bulls. Wash. Agr. Exp. Station, Bulletin 158, 1920.

. . . Rainfall Intensity

(Continued from page 347)

sufficient record length were available for adequate testing of shape or orientation of pertinent areas. Much of the scatter is probably error in estimating average areal depths.

Seasonal Variation

With seasonal variation in the rainfall-runoff relationship, a 10-year flood, for example, may not necessarily come from a 10-year rain. Snow cover, frozen soil, condition of vegetation and other seasonal variables affect the rainfall-runoff relationship.

To analyze rainfall characteristics in the Ohio Valley, seasonal variation of the rainfall intensity-duration-frequency regime was investigated. Tests showed no systematic variance from station to station within this region, and no significant variation with size of area up to 400 square miles. Duration was found to be an important variable.

Fig. 5 illustrates, for 1-hr duration, the type of diagram disclosed by examination of the data. The ordinate scale is the magnitude of the yearly values, expressed in terms of return period. The horizontal scale is time of year, by months. The curves represent the probability, in percent, of occurrence during any calendar month, of an event having the magnitude corresponding to the ordinate scale. There is, for example, a 2 percent chance of a 20-year 1-hr rain occurring in July or August of a particular year.

References

1 U. S. Weather Bureau, Rainfall intensity-duration-frequency curves for selected stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico, Technical Paper No. 25, December 1955.

2 U. S. Weather Bureau, Rainfall intensities for local drainage design in the western United States, Technical Paper No. 28, November 1956.

3 Spreen, W. C. A determination of the effect of topography upon precipitation, Trans. American Geophysical Union, pp. 285-290, April 1947.

4 Linsley, R. K. The relation between rainfall intensity and topography in northern California, Department of Civil Engineering, Stanford University, June 1956.

5 U. S. Weather Bureau. Rainfall intensity-frequency regime, Part I: The Ohio Valley, Technical Paper No. 29, June 1957.

Offers Translation Service

A NEW translation service has been established by the Special Libraries Association Translation Center, located at the John Crerar Library in Chicago. According to a recent announcement the service can now furnish, on subscription basis, printed catalog cards for current scientific and technical material which has been translated into English from all languages, including Russian.

Subscriptions to translation catalog cards are available in the following: (a) full coverage of *Translation Monthly*, the center's bibliographical journal (approximately 12,000 titles yearly); (b) coverage of all translations currently received by the center (approximately 6750 titles yearly); (c) coverage of all Russian translations received by the center (approximately 3100 titles yearly); and (d) coverage of all titles in specific subject fields.

The SLA Translation Center was established at the John Crerar Library in 1953 with an original collection of 932 translations. At the present time more than 20,000 titles are listed, and approximately 6750 are being added annually. In January 1958, the Russian translations then housed in the Scientific Translations Center at the Library of Congress were taken over by the SLA Translation Center. This added 4000 Russian items to the collection, and since then Russian material has been received regularly at the rate of 3100 items per year.

Partially supported by grants from the National Science Foundation and the National Institutes of Health, the SLA Translation Center is a depository for unpublished scientific material which has been translated into English from all languages. It actively solicits and collects translations from government agencies, industry, technical societies, and educational institutions and makes copies of these translations available to other research groups and individuals. Users may borrow paper copies of desired translations or may purchase for permanent retention microfilms or photoprints of translations.

Further information about the SLA Translation Center and its services may be obtained from SLA Translation Center, John Crerar Library, 86 Randolph St., Chicago 1, Ill.

Correction

THE following error has been brought to our attention regarding the article "Statistics Help Evaluate Functional Components of Farm Machinery," by William T. Mills and David D. Mason, which appeared in the January, 1958 issue: In Table 1, the figures listed under 16 days are: 3.12, 2.88, 2.76, 2.70. Figures under 16 days should be, 6.43, 5.93, 5.68 and 5.56.

Strain Gage Courses

AN INTENSIVE lecture and laboratory program in strain gage techniques will be offered August 18 through 29 at the University of California, Los Angeles, by the Department of Engineering, Engineering Extension, and the Society for Experimental Stress Analysis.

The program will be divided into two courses, the lecture course running from August 18 through 22, and the laboratory course from August 25 through 29.

Information and applications may be obtained from Engineering Extension, University of California, Los Angeles 24.

The Falling Water Table in Tile Drainage, by James N. Luthin and Robert V. Worstell, respectively, associate professor of irrigation and principal laboratory technician, drainage research, irrigation department, University of California, Davis. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-545.**

An experiment was performed in a full-scale tank having the dimensions 10 x 6 x 2 ft. The tank was filled with sand, and tiles were placed in the tank to simulate a tile spacing of 20 ft with the tiles placed 4 ft below the soil surface and 2 ft above an impermeable layer. The data collected from the experiment is used to develop some empirical relationships between the flow into a tile line and the height of water table at the mid-point between tile lines. From these relationships a new theory is developed which is based upon certain simplifying assumptions. It is assumed that the water table is flat between tile lines and that the rate of flow of water into the tile line is a linear function of the height of the water table at the mid-point between the drains. An equation for determining distance between tile lines is developed.

Influence of One-Way Disk and Subsurface Sweep Tillage on Factors Affecting Wind Erosion, by N. P. Woodruff and W. S. Chepil, respectively, agricultural engineer and soil scientist, western soil and water management research branch, ARS, USDA, Manhattan, Kans. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-542.**

This paper presents the results of a study of the effect of different depths, speeds, and angles of one-way disk tillage on soil cloddiness, surface roughness, residue placement, and wind erodibility. These results are also compared with those obtained from subsurface sweep tillage. Summer-fallow procedure commonly practiced in raising wheat in the Great Plains in which the one-way or sweep is used both as the initial and cultivation tool was followed. Results are therefore presented for each of three one-way or sweep operations carried out during the summer, after disking and drilling to wheat in the fall, and after natural winter weathering had occurred.

The results showed that subsurface sweep tillage left far more residue on the soil surface than any of the one-way treatments; however, small angle or shallow depth one-way tillage was more effective in leaving residue on the surface than large angle or deep tillage. All one-way tillage treatments produced and maintained more stable non-erodible clods than did subsurface sweep tillage; the greatest proportion of these clods was produced with deep one-way tillage accomplished at slow speeds. Greatest surface roughness and lowest wind erodibility was obtained with small angle or deep one-way tillage and with subsurface sweep tillage.

Seed Harvesting Research in the Southeast, by Joseph K. Park and Byron K. Webb, respectively, agricultural engineer, ARS, AERD, and assistant agricultural engineer, South Carolina Experiment Station. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Power and Machinery Division. Paper No. **57-519.**

Results of studies of harvesting small seeds in the Southeast are summarized in this paper. The research discussed included studies of methods and equipment for harvesting crimson clover, fescue, lespedeza, and a number of other seed crops.

It is pointed out that seed losses are often quite large in these shattering crops, and that harvesting problems may be aggravated by unfavorable weather. An illustration is presented to show the typical trend of harvested yield and seed losses throughout a normal harvest season.

Results are reported on various phases of harvesting including studies of: time of harvest; windrow or swath harvesting; chemical defoliation; seed quality; combine operation and adjustments; combine components; and test results in various crops.

A New Automatic Unloader for Flat-Bottom Bins, by H. B. Puckett, agricultural engineer, Farm Electrification Research Laboratory, AERD, ARS, USDA, University of Illinois, Urbana. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Electric Power and Processing Division. Paper No. **57-599.**

This paper describes a new automatic flat-bottom bin unloader, developed by a USDA agricultural engineer, for providing a continuous supply of feed material for automatic feeding systems. The unloader consists of two augers. One auger draws material from a small hopper located in the center of the bin floor. The second auger is propelled by an electric motor so as to press into the stored material and at the same time convey it to the center hopper. The sweep auger assures that the more stubborn meals will be conveyed to the discharge auger. The chewing action of the sweep auger is sufficient to break a bridge that might form in the stored material. Any material which can be conveyed by the discharge auger can be removed from the storage by this unloader. The unloader becomes an integral part of the bin.

A Method of Determining Average Watershed Precipitation, by Victor I. Myers, irrigation engineer, ARS, University Station, Reno, Nev. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-551.**

An investigation of a watershed problem involves numerous computations of watershed rainfall from a set of precipitation gages. The Thiessen and Isohyetal methods of computing watershed precipitation each have disadvantages.

The paper describes a rapid mathematical method of making computations for solving watershed precipitation problems. The method is adapted to uniform and mountainous terrain. The proposed method is applied to a watershed represented by three precipitation gages. The solution can be applied to watersheds with a greater number of gages.

Development of a Rainfall Simulator for Runoff Plots, by L. Donald Meyer and Donald L. McCune, respectively, agricultural engineer and soil scientist, (SWCRD, ARS) USDA, Purdue University, Lafayette, Ind. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December 1957, on a program arranged by the Soil and Water Division. Paper No. **57-541.**

This paper discusses the design and use of a portable rainfall simulator which has been recently developed at Lafayette, Indiana. The simulator is constructed for use on standard-sized runoff plots as a tool to aid in more rapid evaluation of slope-practice factors that influence erosion, runoff and infiltration. Qualitative evaluation of various topographic, soil, water, crop, and management factors are being made under field conditions.

Commercial spray nozzles were selected to produce the simulated raindrops because their characteristics corresponded most closely to those of natural rainfall. The nozzles spray downward as they are moved across the test plot. Intensities of 2½ or 5 in. per hour with approximately 75 percent the kinetic energy of rainstorms of corresponding intensity are produced. The simulator is constructed in units so that the number and size of plots to which simulated rainstorms may be applied simultaneously may be varied.

The Development of an All-Steel Farm Building for Basic Shelter, by J. Dewey Long, consulting agricultural engineer, Stran-Steel Corp., Detroit, Mich. Presented at the Winter Meeting of the ASAE in Chicago, Ill., December, 1957, on a program arranged by the Farm Structures Division. Paper No. **57-570.**

This paper discusses the development background of a prefabricated all-steel pole barn introduced recently by the Stran-Steel Corp. to explain the steps taken by a manufacturing organization in placing such a building on the market. First step was to make an analysis of the building market, listing the most common end uses and the relative importance of the several functional requirements for each type of use. Then the combined judgment of the agricultural extension group of the organization was utilized for evaluating the current line of farm building designs and locating a type of end use (open shelter) not being served at a price competitive with other types of construction.

Other steps include drafting an illustrated report of the functional and retail price requirements; acceptance of the recommendation by management; field and office studies by the engineering department, including complete analyses of three structural designs before the final one was approved as acceptable for manufacture and marketing; completion of working drawings carrying the seal of a registered engineer and with the structural design meeting the requirements of the Uniform Building Code; hand fabrication and erection of a full-sized prototype building and refinement of some details; pricing and selection of most favorable market promotion activities; erection of demonstration buildings for dealer introduction meetings and for announcement to agricultural leaders; and preparation of a do-it-yourself erection manual and of a motion picture film showing erection procedure.

This column contains letters in which our readers have expressed opinions, suggestions, unusual experiences, or divergent views on subjects of an agricultural engineering nature. It is the intention of the editor to publish a few such letters in each issue of AGRICULTURAL ENGINEERING to encourage free expressions and open debate on pertinent and timely topics.

Supplements Article on Aeration of Grain

TO THE EDITOR:

I would like to discuss a point which has come up among my associates concerning a set of curves (Fig. 9) shown on page 101 of the February, 1958, issue of AGRICULTURAL ENGINEERING. It is part of an article by F. W. Rabe, on Aeration of Grain in Vertical Bins. We do not wish to criticize Mr. Rabe, but to discuss the curves which are attributed to Wilfred Airy (Paper No. 3049, Minutes of Proceedings of the Institution of Civil Engineers, vol. 131, 1897, London, England).

Mr. Airy developed excellent equations for the lateral pressures of grain in bins, in very close agreement with those of H. A. Janssen of Bremen in 1895, but in computing vertical or bottom pressures in tall bins, decreased by friction along the bin wall, he found pressures to be reduced to a minimum for supporting only the pyramidal mass resting directly on the base.

Principles of this theory are indeed reasonable, but the analysis and resulting curves are not continuous. There is a break where the bottom pressure reaches the minimum and then remains constant for greater depths or heights. His theory, if carried out consistently, would have reduced bottom pressures to zero, and even below, a situation apparently impossible.

Many engineers feel that this theory is faulty, and find it difficult to believe that tons of grain added on top of a partly filled bin could actually decrease the load on the bottom.

H. A. Janssen and Milo S. Ketchum (The Design of Walls, Bins, and Grain Elevators, McGraw-Hill Book Co., 1925) show that lateral and vertical pressures are directly related, so that a constant,

$$k = \textit{Lateral pressure}/\textit{Vertical pressure} = L/V$$

and that this situation persists throughout the height of the storage bin, possibly with some variation in k. This is in agreement with the curves of Fig. 9 (Airy) up to the point of maximum vertical pressure, where these curves reverse the trend.

We have observed no research data where this reversal has occurred. On the contrary, data by many researchers (Isaac Roberts, 1884; H. A. Janssen, 1895; Milo S. Ketchum, 1903; J. A. Jamieson, 1900; Henry T. Bovey, 1901; J. Pleissner, 1905; C. C. Williams, 1909, and others) show that the bottom pressures increase gradually to a maximum when the height is 4 to 6 times the diameter, and then remain essentially constant. There is no apparent reduction in vertical or lateral pressures due to an increase in depth, and very little change in the value of k.

Two critical aspects of Airy's solution might cause serious trouble if applied carelessly:

(a) Some types of floors and equipment would probably collapse if designed to support only the pressures indicated by Airy's principles and curves.

(b) Even if his theory were correct, bottom pressures on a bin partly full would greatly exceed the design strength, causing failure of floor or vents prematurely.

L. W. NEUBAUER.

University of California,
Davis, Calif.

Early Treatise on Agricultural Engineering

TO THE EDITOR:

Recently I encountered in our library a textbook of considerable historical interest: Rudimentary Treatise on Agricultural Engineering, by G. H. Andrews, agricultural engineer, published in London in 1852 and 1853. Volume I is subtitled Buildings; Volume II, Motive Powers and the Machinery of the Homestead; and Volume III, Field Machines and Implements.

Each volume is small—some 130 pages—but the booklets are full of interesting statements of then current practice and of the author's philosophy concerning the need for more efficient farming methods. On page 8, volume I, he states, ". . . if high farming will not pay, low farming cannot." One of the impressions left by these books is that we have not made as much progress as we thought in the last 100 years. For example, Andrews describes a mole plow with depth control used to pull in a drain lining behind the mole, and shows a picture of the "Norwegian Harrow" which is not very different from a modern rotary hoe.

In leafing through these booklets, I was reminded of Professor Henry Giese's article in the Golden Anniversary Issue of AGRICULTURAL ENGINEERING, June, 1957, and his discussion of the early uses of the term "agricultural engineer." Certainly this early work deserves a place in the history of the profession, even if it does concern agricultural engineering activity in England rather than in the United States.

JAN VAN SCHILFGAARDE.

Associate professor, agricultural engineering,
North Carolina State College
Raleigh, N. C.

Report from Pakistan

TO THE EDITOR:

You, no doubt, have wondered what became of that man H. P. Smith who disappeared from ASAE activities shortly after the 1956 annual meeting at Roanoke, Va.

On July 10, 1956, I left the Texas A. & M. College Campus for a 2-year foreign assignment in East Pakistan. Officials of Texas A. & M. College asked me to assume the duties of chief of their ICA-Texas A. & M. College Contract program in East Pakistan. The College had entered into a contract with the U.S. International Cooperative Administration to furnish a maximum of 18 staff members to work with the affiliated Colleges of the University of Dacca.

As chief of the party, my duties are largely administrative and deal almost entirely with college educational functions in an underdeveloped country. The work here is naturally entirely different from the research work on cotton harvesting equipment I had been doing for more than a quarter of a century.

It is interesting to work in a country which has such an ancient historical background and where some age old customs still prevail. Then, too, Pakistan is about the only nation of the world which is made up of two provinces separated by about 1,000 miles and by another nation. East Pakistan has a land area, comparable to the State of Illinois, excluding rivers, of 54,141 square miles (34,650,240 acres) with an estimated population of 45 million. The density of the population, per square mile, ranges from almost zero in the Sundarbans (coastal delta area) to around 2,000 along the rich river plains. It is estimated that there are 61,000 villages in East Pakistan.

About 90 percent of the population depend on the land for their food and living. The principal crops are cereals, rice, sugar cane, tea, fiber crops (jute, sunhemps, and cotton) pulses, rape, mustard, fruits and vegetables.

The average rainfall for East Pakistan is approximately 82.4 in. The eastern districts near the Himalayan mountains receive 90 to 140 in. while the western districts adjacent to Delhi, India, receive 50 to 60 in. Most of the rainfall occurs during the monsoon season from June to September. The winter months are dry and irrigation is necessary to grow crops. The winter temperature rarely drops below 50 F. Crops can be grown the year round with the proper distribution of water or irrigation in the winter months.

The application of mechanical methods to agriculture in this country is a challenging problem. The cultivated plots or paddies average about ¼ acre or less in size. A paddie is a small level area of land surrounded by a low dike, for holding water, about 1½ to 2 ft in width and of equal height. The average production of food per family unit is on a minus subsistence level. Therefore, the income is not sufficient to purchase more than a hoe or wooden plow per generation.

Efforts to develop a good primary and secondary school system is a problem where sections of country speak different languages. School buildings and facilities are meager. I have visited some primary schools where 60 children were crowded into a 20 by 20 ft room. The children were sitting on benches, with no desks, so close that their hips were touching. Education on a college level is seriously handicapped by the lack of facilities, equipment, organization, and trained personnel.

The primary objective of the ICA-Texas A. & M. College Contract program is to provide technicians to aid in revising and organizing syllabi, curricula, and provide equipment for a better training program. Other objectives are the training of staff counterparts and sending abroad staff members for training.

The College Contract technical assistance program is only a small part of the over-all U.S. Foreign Aide Program.

H. P. SMITH.

Chief of Party, Pakistan Program,
ICA-Texas A. & M. College Project,
c/o American Consulate General,
Dacca, East Pakistan

Corporate Name Change

The shareholders of the Rockwell Spring and Axle Co., Coraopolis, Pa., recently approved a change in the corporate name to Rockwell-Standard Corporation. A subsequent report stated that Blood Brothers Machine Division, manufacturers of universal joints for agricultural, truck and industrial applications, will be known as the Universal Joint Division of Rockwell-Standard Corp. The report explained that "Blood Brothers" will be retained as a trade name for universal joints and drive line assemblies built at the Allegan, Mich., plant.

Announced also is the change of the former Timken-Detroit Axle Division to the Transmission and Axle Division, Rockwell-Standard Corp. The management reports that the new name is less restrictive in regard to products, since the division, in addition to Timken-Detroit axles, manufactures a wide range of transmissions, torque converters and special power transmission units for automotive, agricultural and industrial applications.

AE Student Sets Grade Record

Ronald C. Hamelink, student member of ASAE and agricultural engineering senior, graduates this month with the highest scholastic record ever made at Michigan State University. The 25-year old married student, father of two small daughters, compiled a four-point average, the equivalent of an A-grade for every credit hour.

Registrar Kermit H. Smith said that Hamelink, while piling up 250 credits as against the 212 required to graduate, received three B's, but repeated the courses and was awarded an A the second time. Hamelink explained the repeats as motivated by pride and a desire for perfection.

He plans to do graduate work at Michigan State during the summer and to attend the University of Chicago in the fall to study mathematics on a National Science Foundation fellowship.

ASAE MEETINGS CALENDAR

June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

August 25-27—North Atlantic Section, Guelph, Ontario, Canada.

October 22-25 — Pacific Northwest Section, Oregon State College, Corvallis, Ore.

October 30-31—South Carolina Section, Clemson Agricultural College, Clemson, S. C.

December 17-19 — Winter Meeting, Palmer House, Chicago, Ill.

April 3-4 — Mid-Central Section, Hotel Robidoux, St. Joseph, Mo.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Fifth Agricultural Engineering International Congress

Several ASAE members have indicated an interest in attending the Fifth International Congress of Agricultural Engineering to be held during the World Fair in Brussels, Belgium, September 29 to October 4. Those interested in making the trip with other agricultural engineers or who would like to be part of the official ASAE representation are urged to notify J. L. Butt, executive secretary of ASAE, 420 Main St., St. Joseph, Mich. Further details concerning the event may be obtained upon request.

Tractor Exhibition Postponed

Word has been received from the organizing committee that the 2nd International Tractor Exhibition scheduled for May 10 to 18 in Turin, Italy, has been postponed until fall. The show has been rescheduled to take place in conjunction with the International Technical Exhibition from which it originated. Date and place have not been announced. Further information may be obtained by writing to Servizio Stampa del, Salone Internazionale del Trattore-Torino, Palazzo Delle Esposisioni Al Valentino, Turin, Italy.

Cal Poly Visit Offered

An invitation cordially extended from the students and staff of California State Polytechnic College urges members to visit their campus en route to or from the ASAE Meeting to be held in Santa Barbara. Members of the student body and staff will conduct tours of the campus and will be on hand at the agricultural engineering department Saturday and Sunday, June 21 and 22, as well as Thursday, June 26, following the meeting.

The college is located at San Luis Obispo, 100 miles northwest of Santa Barbara on U.S. Highway 101, with the farm and campus covering 2850 acres of Southern California's scenic coastal foothills.

Of the 4,000 students enrolled, 1,040 are in the agricultural division, with 250 undergraduates majoring in the agricultural engineering department. Visitors are invited to sit in on any of the sessions held during the California Agricultural Teachers Association conference to be held on the campus June 23-27 or in any of the refresher classes to be held June 17-21, including several in the field of farm mechanics and agricultural engineering.

(Continued on page 370)

BULLETIN

Word has been received from the Local Arrangements Committee of the Pacific Coast Section that campus housing and food service facilities for those attending the Annual Meeting will not be available until Sunday evening, June 22. It is suggested that those arriving before Sunday make motel or hotel reservations through the sources mentioned in the mailing information.

EVENTS CALENDAR

June 16-20 — 66th Annual Meeting of *American Society for Engineering Education*, University of California, Berkeley, Calif. Contact W. Leighton Collins, Sec., ASEE, University of Illinois, Urbana, Ill.

June 17-20 — Joint meeting of the *American Grassland Council* and the *American Dairy Science Association*, Raleigh, N. C. For further information write to Z. W. Craine, Sec'y-Treas., American Grassland Council, P.O. Box 30, Norwich, N. Y.

June 29 - July 11 — *Short Courses on Materials Engineering Design for High Temperature* at Pennsylvania State University to keep design engineers and others engaged in research on materials abreast of new development in the field. For further details contact Joseph Marin, Engineering Mechanics Dept., Pennsylvania State University, University Park, Pa.

July 20-26 — 15th Annual *National Farm Safety Week*, co-sponsored by the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., and U.S. Department of Agriculture.

August 12 - 14 — *Cotton Production and Mechanization Conference*, Brownsville, Texas. Details may be obtained by writing Farm Equipment Institute, 608 S. Dearborn St., Chicago 5, Ill.

August 21-22 — *16th National Plowing Contest and Conservation Exposition*, The Hershey Estates, Hershey, Pa. Contest rules may be obtained from Leland H. Bull, General Chairman, NPCCE, 127A South Office Bldg., Harrisburg, Pa.

September 3-20 — International Engineering "Package" Meetings — *Fifth Convention of the Pan American Federation of Engineering Societies (UPADI)*, Sept. 3-6, Montreal, Canada. *Sectional Meeting of the World Power Conference*, Sept. 7-11, Montreal, Canada. Study Tour, Sept. 11-14, to St. Lawrence River Navigation and Power Projects, to Niagara Falls, to the Nuclear Power Station at Shippingport and to New York City. *Sixth International Congress on Large Dams*, Sept. 15-20, Statler Hotel, New York, N. Y. For further details contact G. A. Hathaway, chairman, 4316 Van Buren St., University Park, Hyattsville, Md.

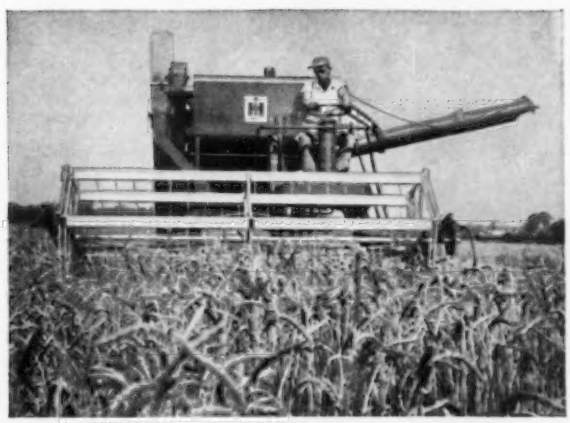
September 17-19—*Farm Materials Handling Conference*, Iowa State College, Ames, sponsored by American Society of Agricultural Engineers. For further details see page 130, March 1958 issue of Agricultural Engineering, or write ASAE, 420 Main St., St. Joseph, Mich.

September 22-24 — *7th Annual Meeting of Standards Engineers Society* at Benjamin Franklin Hotel, Philadelphia, Pa. For further details contact F. F. Van Atta, 1916 Race St., Philadelphia 3, Pa.

September 29 - October 1—*Farm Equipment Institute Convention*, Atlantic City, New Jersey. For information write FEI, 608 S. Dearborn St., Chicago 5, Ill.

September 29 to October 4 — *Fifth International Congress of Agricultural Engineering* to be held in Brussels, Belgium. The aim is to stimulate the science and the techniques of agricultural engineering, as well as the use of these techniques; and to coordinate scientific research and techniques in the fields related to agricultural engineering. Registration information may be obtained by writing to M. Nestor Laret, Avenue des Combattants, 69, Gembloux, Belgium.

Get huge acre-eating capacity...
SAVE GRAIN OTHERS LOSE!



McCormick No. 101, now more than ever, best buy of its class, has all the crop-saving features of the mighty No. 151. New corn unit . . . new choice of 10 or 12-foot cut let you make fullest use of big 28-inch separator and rugged 55 hp IH engine. Use 12-foot platform in sorghum or beans to harvest four rows while drive wheels straddle two. Both combines are centered on row-matching treads, for easiest handling . . . to open corn fields with no "down row."

Your first round in a heavy-yield crop proves the new McCormick® No. 151 whopping big from end to end . . . not just another combine with oversized cut. Watch the big platform with "deep-set," 20-inch auger take a cleaner, faster 15-foot bite, even in down and tangled crops. See how even-flow feeding, three-point separation, and opposed-action cleaning add grain-saving capacity to the huge, 37 3/16-inch separator.

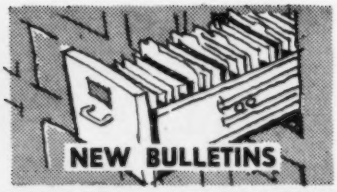
Keep harvesting when wet ground and tough threshing stop others. Close-governed 70 hp IH engine holds steady speed in heaviest going . . . big drive wheels carry 80% of the weight for sure traction, easier steering. Choose 15, 14, or 12-foot platform. Big capacity corn unit available.

Speed your 1958 harvest with a grain-saving McCormick self-propelled. Your IH dealer is the man to see.

See Your
INTERNATIONAL HARVESTER Dealer

International Harvester Products *pay for themselves in use*
—Farm Tractors and Equipment . . . Twine . . . Commercial Wheel Tractors . . . Motor Trucks . . . Construction Equipment
—General Office, Chicago 1, Illinois.

(For more facts circle No. 74 on reply card)



Soil Moisture Tensiometer, by S. J. Richards and R. M. Hagan. California Agricultural Experiment Station, Extension Service, University of California, Davis, Calif.

Farm Electrification Institute, 1958, abstracts of papers presented at the New England Council. Cooperative Extension Service, College of Agriculture, University of Massachusetts, Amherst, Mass.

Maintenance Inspection of Sixty Farm Tractors, by J. A. Weber. Bulletin 624. University of Illinois, Agricultural Experiment Station, Urbana, Ill.

Environmental Physiology and Shelter Engineering, Research Bulletin 642 — XLII, Effects of Constant Environmental Temperatures of 50 F and 80 F on the Growth Responses of Brahman, Santa Gertrudis, and Shorthorn Calves, by J. H. Longwell; Research Bulletin 643 — XLIII, Energy Metabolism and Cardiorespiratory Activities in Shorthorn, Santa Gertrudis, and Brahman Heifers During Growth at 50 and 80 F Temperatures, by Hudson H. Kibler, and Research Bulletin 645 — XLIV, Stable Heat and Moisture Dissipation with Beef Calves at Temperatures of 50 and 80 F, by R. G. Yeck. Copies are available by writing Missouri Agricultural Experiment Station, University of Missouri, Columbia, Mo.

Wood, Plywood or Steel Gusset Plates for Nailed Trussed Rafters and *Holding Power of Large Nails and Spikes in Dry Southern Pine,* by E. George Stern, Virginia Polytechnic Institute, Wood Research Lab., Blacksburg, Va. Bulletin Nos. 29 (March, 1957) and 30 (April, 1957), respectively.

Planting in the Mechanization of Cotton Production. Southern Cooperative Series, Bulletin No. 49. Agricultural experiment stations of Alabama, Arizona, Arkansas, California, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Texas and ARS, U.S. Dept. of Agriculture. Requests from outside the cooperating states should be addressed to the Mississippi Agricultural Experiment Station, State College, Miss.

The ABC's of the Farm Problem, by John L. Strohm. Channing L. Bete Co., Inc., Greenfield, Mass. Price 25 cents per copy.

SAAE & VA Publications and Filmstrips, Coordinator's Office, Southern Ass'n. of Agricultural Engineering & Vocational Agriculture, Barrow Hall, Athens, Georgia.

Seal of Approval Listing of Plastic Materials, Pipe, and Fittings for Potable Water Supplies, published by National Sanitation Foundation Testing Laboratory, Inc., Ann Arbor, Mich.

Estimating Soil Moisture and Tractionability Conditions for Strategic Planning, Air Force Surveys in Geophysics No. 94, March 1958, by C. W. Thornthwaite, J. R. Mather, D. B. Carter and C. E. Molineux. Geophysics Research Directorate, Air Force Cambridge Research Center, Air Research and Development Command, U.S. Air Force, Bedford, Mass.

Vermiculite Concrete Roof Insulation and Roof Decks, Vermiculite Institute, 208 South La Salle St., Chicago 4, Ill.

A New Method of Terracing, Station Bulletin 699, by R. P. Beasley. University of Missouri, Agricultural Experiment Station, College of Agriculture, Columbia, Mo.

A Hydrologic Survey of Small Water Storage Structures, by R. H. Burgy and R. L. Ferral. University of California, Department of Irrigation, Davis, Calif.

Interception Losses in Grassy Vegetation, by R. H. Burgy and C. R. Pomeroy. University of California, Department of Irrigation, Davis, Calif.

The Control of Roadside Erosion, by A. K. Turner. Soil Conservation Authority, 378 Cotham Road, Victoria, Australia.

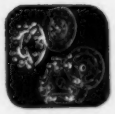
Stand Your Ground, Rural Electrification Education Series No. 24, by Clyde T. Ellis. National Rural Electric Cooperative Association, 2000 Florida Ave., N.W., Washington 9, D.C.

The Availability and Use of Water in Georgia, Bulletin No. 65, by M. T. Thomson, S. M. Herrick, Eugene Brown, and others. State Division of Conservation, Department of Mines, Mining and Geology, 19 Hunter St., Atlanta, Ga.

Digest of Proceedings of the Industry-Research Conference, Farm Equipment Institute, 608 South Dearborn St., Chicago 5, Ill. Price 50 cents per copy.

Reports of the 6th International Congress of Soil Science, held in Paris, September, 1956. Office International De Librairie, 30, Avenue Marnix, coin rue du Luxembourg, Bruxelles, Belgium. Price of 4 volumes containing over 2,600 pages, $45.00.

ROCKFORD



Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

RM CLUTCHES
Provide Cushioning and Vibration Dampening

ROCKFORD R-M CLUTCHES are well adapted for use on wheeled vehicles and machines where a foot pedal engages and disengages the clutch, or where cushioning the engagement of the driving unit is required. May be had with or without the vibration dampening feature. Arranged with flat cover for use with counterbored flywheel or cupped cover for use with flat flywheel. Facings available for dry or in-oil operation.

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
1325 Eighteenth Ave., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

Electricity in Agricultural Engineering, by Truman E. Hienton, Dennis E. Wiant, and Oral A. Brown. Cloth, 6 x 9 inches, 393 pages, illustrated and indexed. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $7.75.

The new book is the sixth in the Ferguson Foundation Agricultural Engineering Series and presents a practical discussion of the application of electric energy to research and design problems in agriculture, which assists in developing new methods, or improving old methods for using electric energy on the farm. It shows how to plan an approach to a specific design problem, such as the design of farmstead electric systems, the choice of correct voltage and wiring for specific loads, and the selection of the correct motor to supply power for a specific job.

Spraying Techniques in Agriculture, S.C.I. Monograph No. 2. Cloth, 5½ x 7½ inches, illustrated and indexed, iv + 117 pages. Published by the MacMillan Co., 60 Fifth Ave., New York 11, N. Y. $4.00.

This book is comprised of papers, with discussion, read at a symposium organized by the Pesticides Group of the Society of Chemical Industry held at the Wellcome Building, London, England. It includes a comparison of high and low-volume spraying techniques on fruit and ground crops — concentrate spraying, orchard trials with undiluted lime-sulphur, spraying potatoes and in pine plantations, levels and distribution of deposits, spray techniques for fruit, droplet formation and assessment, air-assisted fruit-spraying machinery, and low-volume spraying in East Africa.

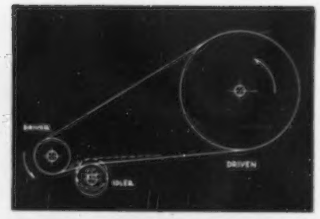
Proceedings of the World Conference on Prestressed Concrete. Copies may be obtained from the World Conference on Prestressed Concrete, Inc., Room 216, 417 Market St., San Francisco 5, Calif. $10.00.

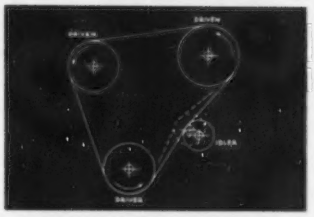
This 600-page book contains 64 papers presented by delegates from all over the world who attended World Conference on Prestressed Concrete held in San Francisco in July 1957. The papers cover many uses of prestressed concrete throughout the world in buildings, bridges, piling, airfields, dams and poles — from points of design, manufacture, construction and research.

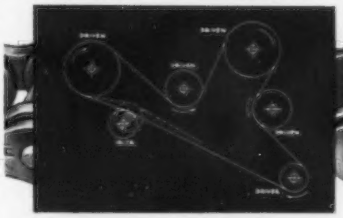
The Literature of Agricultural Research, by J. Richard Blanchard and Harald Ostvold. Cloth, 6 x 9 inches, 231 pages, indexed. Published by University of California Press, Berkeley 4, Calif. $5.00.

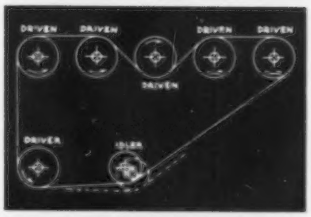
This is the first of a series of bibliographic guides sponsored by the University of California libraries and issued by the University of California to meet the information-locating problems posed by vast growth of agricultural research in recent decades. It is an annotated, descriptive guide to reference works.

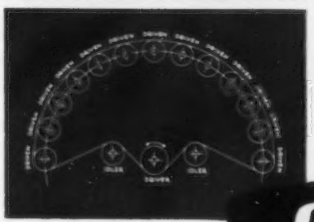
The book is a key to the reference works of agriculture to date, and lists bibliographies, histories, dictionaries, encyclopedias, and other works designed to summarize information in concise form. It provides an initial, broad survey of agricultural reference works, evaluates them to some extent, and suggests procedures for tracking down facts.











for efficiency and economy

drive it with ACME chains and sprockets

In any drive where maximum efficiency is essential you will find Acme precision roller chain and sprockets are readily adaptable. Illustrated at the left are several drive applications.

Use Acme Chain drives wherever dependable, efficient and economical transmission of power between parallel shafts is required. Their correct principle of design provide operating characteristics superior to any other means of power transmission. Acme Chains and Sprockets deliver Positive — Efficient — Economical — Flexible — Rugged — and Quiet Power Transmission. Send your power transmission problems to Acme for the right solution.

Write Dept. 9-L for new 100-page Illustrated Catalog, including new engineering section showing diagrams of 36 methods of chain driving.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Call ACME for Service

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

(For more facts circle No. 55 on reply card)

R. R. Roth

J. D. Morris

R. G. Ferris

Robert R. Roth has accepted a position of product engineer as head of Harvesting Machinery Division with J. I. Case Co., Rockford Works, Rockford, Ill. With this acceptance he is terminating the position of project engineer in charge of tillage implements with Minneapolis-Moline Co. after 10 years. In September of 1947 he started as design engineer at Moline, Ill., being promoted to assistant chief engineer in 1954. He was transferred to Minneapolis in 1955.

J. D. Morris has been promoted to sales manager of the new Utility Tractor and Equipment Sales Department, Allis-Chalmers Mfg. Co. He will be in charge of utility products sold through dealers in the farm equipment, construction machinery, and engine-material handling divisions of the company. Morris started with Allis-Chalmers at its Atlanta branch following his graduation from Alabama Polytechnic Institute at Auburn. He has been a home office factory sales representative for the company since 1954.

Robert G. Ferris, vice-president in engineering of Starline, Inc., has in addition been elected chairman of the board of directors of that firm. He has been connected with the company for 28 years, starting in the pattern department in 1929, and made a vice-president in 1947. He is the grandson of Henry L. Ferris, one of the founders and original partners of Hunt, Helm, Ferris & Co., the original name of the firm, now in its 76th year.

Edward G. Molander has retired after 29 years of service with the U.S. Department of Agriculture. Except for three years in the armed service where he was assigned to the duties of assistant regional engineer with the Defense Plant Corporation, he has been connected with the Agricultural Engineering Research Division of Agricultural Research Service, specializing in farm structures.

Although born in the United States, Mr. Molander's extensive experience in building design and construction began in Sweden where he practiced in private industry after earning the degree of building engineer from the Technic College at Stockholm, in 1916. He returned to the United States in 1920, accepting assignments in Ohio, New York and Florida on school, factory and other buildings.

In 1929 he began his federal career when he became engaged in structural design for a new addition on the U.S. Government Printing Office, followed by assignments with the office of Quartermaster General, War Department, for hospitals, barracks, and other buildings. He joined USDA in 1933. During his career he has served as engineer in charge of the structural design of office, laboratory and other buildings at the Agricultural Research Center, Beltsville, Md., and of the four Regional Utilization Laboratories of ARS at Philadelphia, Peoria, New Orleans, and Albany.

As consulting engineer for the Commodity Stabilization Service he has been largely responsible for the engineering aspects of the design, procurement, and inspection of the storage structures of the agency's grain storage program.

Mr. Molander has written over 20 circulars, bulletins and articles based on results of his research. At the present he is spending part time translating Swedish technical material for his former office. The esteem in which he is held in both government and industrial circles speaks for the high quality of service he has rendered his profession.

E. G. Molander

B. A. Jennings

NECROLOGY

Albert W. Cook, Sr., system senior agricultural sales engineer for the Appalachian Power Co. at Roanoke, Va., died on April 28. He had been critically ill for several weeks suffering from cerebral hemorrhages. Mr. Cook, a native of Roanoke County, received the B.S. degree in agricultural engineering at Virginia Polytechnic Institute in 1933. Before joining APCO in 1936, he taught mathematics in high school and served as assistant county agent in Appomattox County. He was a reserve lieutenant-colonel in the army's 2174th Garrison Unit and served in the European Theater during World War II. He became a member of ASAE in 1952.

Eugene A. Ffolkes, who in September, 1957, was awarded a scholarship by the Jamaican Government to undergo practical training and observation of irrigation and drainage practices in the United States, has, since, been attached to the Soil Conservation Service, Agricultural Research Service of the U.S. Department of Agriculture, touring various states. He has been in Washington, D.C., Maryland, South Dakota, Nebraska, California and Arizona. He is now located in Washington, going from there to Colorado during July and August and then back to Washington, D. C. in September.

Dwight F. Kampe will join the staff of the University of Illinois in Urbana as associate professor with primary responsibility in the farm power and machinery area on July 1. He graduated from Michigan State University with an M.S. degree in agricultural engineering. At present he is employed with the Ford Motor Company in the Tractor and Implement Division.

Harley E. Bergren, formerly field engineer with Gates Rubber Co., has become associated with Char-Lynn Co. of Davenport, Iowa, as division manager.

Sanford B. Taylor, formerly connected with Standard Accident Insurance Co., has become associated with Martin Steel Products Corp. of Mansfield, Ohio, as vice-president.

B. A. Jennings, professor of agricultural engineering, will retire from the Cornell University faculty June 30. His association with the New York State College of Agriculture dates back to 1916, when he took his first job with the farm practice department. During his undergraduate days he also worked as an instructor in the State Food Commission's Tractor schools and operated a power ditching machine.

Following graduation from Cornell in 1921, he taught at the George Junior Republic in Freeville. After one year he returned to Cornell to teach a course in agricultural engineering.

Upon completion of one year of resident teaching, he carried on extension work. Throughout the state he held gas engine schools and started tractor and field machinery schools where farmers brought tractors and other machines to learn how to adjust and repair them.

In 1938 he returned to classroom teaching. He started a course in farm machinery and taught farm power and farm mechanics courses. In addition he did extensive research on milk houses, milk cooling, orchard spray equipment, and hay driers.

At Cornell he has been in charge of fence exposure testing. This research on wire fencings of all kinds is conducted in cooperation with the American Society of Testing Materials and with other colleges.

Russell E. Heston, previously associated with the University of Illinois as associate professor of agricultural engineering will become affiliated with the Iowa Mutual Reinsurance Association of Grinnell, Iowa, working as staff engineer.

Theodore J. Shambaugh, Jr. recently returned for a short vacation from a two-year ICA assignment in Lebanon. He will be stationed in Yugoslavia after completing his vacation.

Robert R. Rowe has been promoted from assistant manager to manager of the Industrial Research Division of the Doane Agricultural Service of St. Louis, Mo. He has been connected with this firm since 1949.

MANUFACTURERS' LITERATURE

Clinch Nuts

Elastic Stop Nut Corp. of America—This design manual No. 5803 is an 18-page indexed and illustrated handbook which reviews available standard and miniature clinch nuts. The shank-type fasteners are said to be self-retaining and self-locking and especially suitable for attaching cover plates or mounting component metal or plastic panels.

(For more facts circle No. 1 on reply card)

Fluid Measuring Valves

Lincoln Engineering Co. — Bulletin No. 682 is an illustrated bulletin containing information on measuring valve systems designed for industrial applications to help solve problems in dispensing measured quantities of fluid and semi-fluid materials from $\frac{1}{20}$ oz. to more than 2 qt per application.

(For more facts circle No. 2 on reply card)

Hose Assemblies

Eastman Mfg. Co. — A 32-page technical bulletin No. 200 on high pressure hose assemblies and couplings. Nine major sections of the bulletin are devoted to couplings suited to hydraulic applications, including bent tube, automotive power and air conditioning assemblies.

(For more facts circle No. 3 on reply card)

Roofing and Siding

United States Steel — A 22-page bulletin, "USS Galvanized Roofing and Siding" illustrates the company's metal roofing and siding, lists application tips, and describes methods of computing square footage of sheets required.

(For more facts circle No. 4 on reply card)

Power Farming Packet

Caterpillar Tractor Co. — A package of materials titled "Successful Power Farming" composed of illustrated, colored booklets containing information compiled to help the farmer in use of deep tillage, farm layout planning, and soil and water conservation. The booklets give background material on the small watershed program and the steps necessary to start it on a local level, information on land clearing and application of machines to best advantage, and a cost record booklet for machine operating costs.

(For more facts circle No. 5 on reply card)

Metal Stitching

Acme Chain Co. — A 16-page booklet, "Metal Stitching, a New Idea in Fastening," gives information on stitching metal to metal or metal to non-metallic materials and illustrates applications. The company's steel metal stitchers are pictured with drawings and charts giving their specifications.

(For more facts circle No. 6 on reply card)

Hay Conditioner

Ray Cunningham and Sons, Inc. — A 6-page illustrated folder describing the company's hay conditioner.

(For more facts circle No. 7 on reply card)

New Lubricant Pumps

Lincoln Engineering Co.—A 32-page, two-color catalog No. 65 covers design and engineering features for the complete series of 67 new Power-Master pumps and allied equipment, and contains lubricant-output-performance and selection charts.

(For more facts circle No. 8 on reply card)

Metal and Plastic Processes

Ainsworth-Precision Castings Co. — A 4-page folder describing the metal and plastic processes performed as a result of recent corporation mergers. Design and production data is given for die casting, stamping, precision machine parts, metal forming, plastic molding, welding, assembly, automatic plating, automatic polishing and buffing, painting, and die making.

(For more facts circle No. 9 on reply card)

Ladder-Type Trencher

Parsons Company offers a 4-page bulletin on the recently introduced Parsons 77 Trenchliner. Photos describe how the 3-ft, 10-in. width and 5-ft, 8-in. height permit the new ladder-type trencher to operate in close quarter areas.

(For more facts circle No. 10 on reply card)

Bearings Bulletin

The Kaydon Engineering Corp.—A 6-page bulletin, No. 57, containing photos and drawings illustrating the company's line of standard and special ball, roller and needle bearings.

(For more facts circle No. 11 on reply card)

Engine Bulletins

Hercules Motors Corp.—Two 2-page revised and photo illustrated bulletins describe, respectively, two-cylinder and four-cylinder air-cooled gasoline engines. Basic installation diagrams and power chart indicating horsepower rating, torque, and performance characteristics with which ratings can be determined under varying conditions in a number of applications are included in each.

(For more facts circle No. 12 on reply card)

JUST PUBLISHED!

The latest in the Ferguson Foundation Agricultural Engineering Series . . .

1. ELECTRICITY IN AGRICULTURAL ENGINEERING

By TRUMAN E. HIENTON, U.S. Department of Agriculture; DENNIS E. WIANT, Michigan State University; and ORAL A. BROWN, U.S. Department of Agriculture.

A practical discussion of the application of electric energy to research and design problems in agriculture, which enables you to develop new methods, or improve existing methods for using electric energy on the farm. Shows you how to plan an approach to a specific design problem, such as the design of farmstead electric systems, the choice of correct voltage and wiring for specific loads, and the selection of the correct motor to supply power for a specific job.

Note these chapter headings: Electricity and Its Relations to Materials — Energy Transfer — Energy Relations — Circuit Relations — The A-C Electric Circuit — Electron Tubes — Alternating-Current Generators — Electric Motors — Materials for Electrical Mechanisms — Power Transformers — Transmission of Electric Energy — Farmstead Electric Distribution — Electric Energy and Radiation — Visible Radiation — Ultraviolet Radiation — Infra-red Radiation — Resistance Heating — Electric Arc Welding — Induction Heating — Dielectric Heating — Sensing Elements and Fundamentals of Controls. 1958. 393 pages. Illus. **$7.75**

Other books in the Ferguson Foundation Agricultural Engineering Series:

2. PRINCIPLES OF FARM MACHINERY. By ROY BAINER and R. A. KEPNER, both of the University of California; and E. L. BARGER, Massey-Harris-Ferguson, Inc. 1955. 571 pages. **$8.75**

3. SOIL AND WATER CONSERVATION ENGINEERING. By R. K. FREVERT and G. O. SCHWAB, both of Iowa State College; T. W. EDMINSTER, U.S. Dept. of Agriculture; and K. K. BARNES, Iowa State College. 1955. 479 pages. **$8.00**

4. AGRICULTURAL PROCESS ENGINEERING. By S. M. HENDERSON and R. L. PERRY, of the University of California, Davis and Los Angeles, respectively. 1955. 402 pages. **$8.50**

5. TRACTORS AND THEIR POWER UNITS. By E. L. BARGER, Harry Ferguson, Inc.; W. M. CARLETON, and E. G. MCKIBBEN, both of the U.S. Dept. of Agriculture; and ROY BAINER, University of California, Davis. 1952. 496 pages. **$7.75**

6. FARM STRUCTURES. By H. J. BARRE, Martin Steel Products Corporation; and L. L. SAMMET, University of California, Berkeley. 1950. 650 pages. **$7.75**

SEND for ON-APPROVAL copies! MAIL THIS COUPON TODAY!

JOHN WILEY & SONS, Inc. AE-68
440 Fourth Ave., New York 16, N. Y.

Please send me the book(s) circled below to read and examine ON APPROVAL. Within 10 days I will either return the books and owe nothing, or I will remit the full purchase price(s), plus postage.

1 2 3 4 5 6

Name_____

Address_____

City_____ Zone____ State_____

☐ SAVE POSTAGE! Check here, if you ENCLOSE payment, in which case we pay postage. Same return privilege, of course.

Addresses Florida Section from Quad City Meeting

What is believed to be the first telephone address by a national ASAE president was arranged by the Florida Section during its Annual Meeting April 25 and 26, in Jacksonville.

A long distance direct-dialing telephone demonstration, by Southern Bell Telephone and Telegraph Co., made it possible for ASAE president Earl Anderson, agricultural extension director, Stran-Steel Corp., to present an address to the Florida Section while attending the Quad City Section meeting in Clinton, Iowa.

Over 100 members and wives witnessed the demonstration in which J. L. Butt, executive secretary of ASAE, placed a direct-dial call from Florida to President Anderson in Iowa. A two-way conversation, the introduction of speaker by Mr. Butt, and a 15-minute address were carried to the Florida audience by loud speaker. The demonstration was well received and offers a solution to the problem ASAE presidents have in making speaking engagements at more than one meeting on the same day.

The two-day session covered a paper on free piston engine by R. L. Irwin, Ford Motor Co., a talk on plastics for agricultural use, by C. E. Staff, Bakelite Co.; and a discussion of professional progress in agricultural engineering, by J. L. Butt.

A panel discussion was held on responsibilities and opportunities of our profession to the agriculture of Florida, with the presentation of papers on soil and water problems that concern the agricultural engineers, by H. C. Nelson; engineering problems in the Florida vegetable industry, by F. S. Jamison, and educational needs to make for better qualified agricultural engineers, by S. E. Dowling. E. S. Holmes, assistant agricultural engineer, University of Florida, was moderator for the panel group. Concluding features of the meeting were a dynamometer presentation and demonstration, by C. Baker, International Harvester Co.; a 4-H presentation, by T. C. Skinner, extension agricultural engineer, University of Florida, and a presentation on production of electricity, by Don Adams, Florida Power and Light Co.

The Membership Committee reported an increase of 21 members during the past year with a total membership of 96. The total registration for the Annual Meeting was 105.

The new officers elected are: chairman, D. S. Harrison, University of Florida; first vice-chairman, D. E. Adams, Florida Power and Light Co.; second vice-chairman, M. H. Byrom, (AERB, ARS), USDA; third vice-chairman, C. W. Davis, Florida Ford Tractor Co.; secretary, S. E. Dowling, University of Florida, and treasurer, H. C. Nelson, SCS, USDA.

Speaker for the banquet Friday evening was Hugh McLlwain, sponsor, Dale Carnegie Courses of Florida, who presented a stimulating address entitled Fourth Dimension. A dancing party followed the banquet.

QUAD CITY SECTION, Clinton, Iowa — ASAE President Earl D. Anderson addresses the Florida Section of ASAE by long distance telephone while attending the Quad City Section. At right is E. G. Rowlett, district engineer, The Torrington Co. and retiring chairman of the Quad City Section

FLORIDA SECTION, Jacksonville, Florida —(Above) J. L. Butt, executive secretary of ASAE, placed a direct-dial long distance call to President Anderson in Iowa and acted as intermediator between speaker and audience

(Right) Members of Florida Section hear an address from President Anderson in Iowa by loud speaker. The feat was made possible by direct-dial long distance telephone demonstration arranged by the program committee of the Florida Section

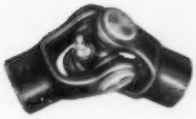
Quad City Section

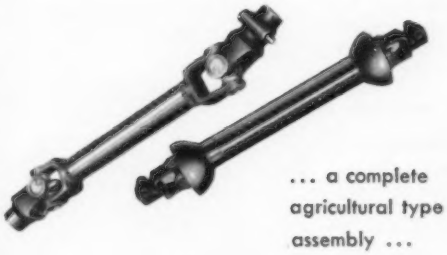
A tour of the DuPont cellophane plant near Clinton preceded the afternoon session of the Annual Meeting of the Quad City Section, held April 26 in Clinton, Iowa. L. R. Dean, DuPont Co., St. Louis, who gave the opening talk, discussed plastic materials application to farm machinery manufacture and was followed by an entertaining as well as informative slant on a work simplification program, given by

(Continued on page 375)

BLOOD BROTHERS works with you to HELP CUT COSTS

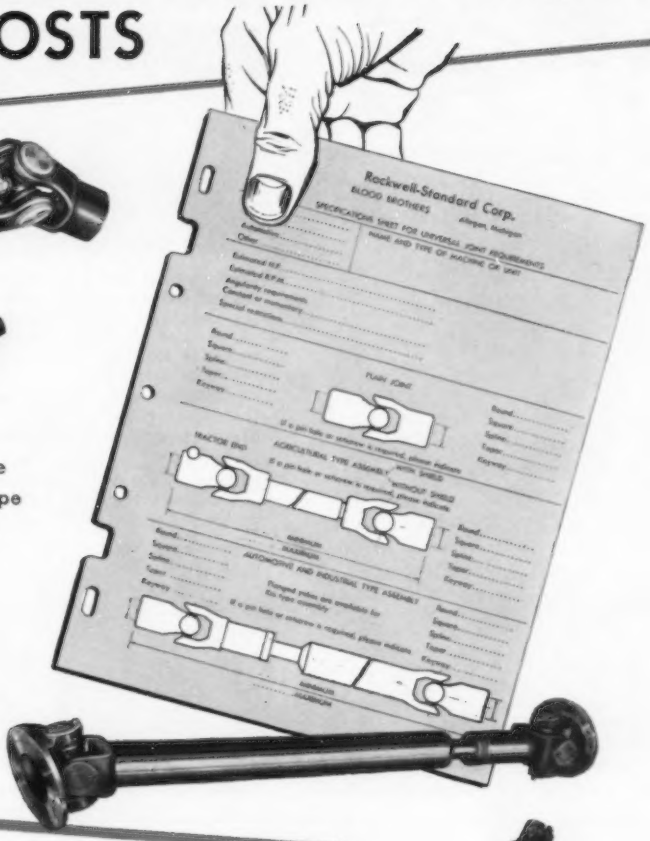
... when your project requires a simple universal joint like this ...





... a complete agricultural type assembly ...

... or automotive and industrial units like these:



YOU CAN SAVE MONEY TWO WAYS:

ONE—Have Blood Brothers review *all* joint and drive line specifications and costs for your *current models*. You'll help *insure* the lowest-cost purchasing of components that fulfill specifications. It's easy to submit data on "Spec Sheets" like that above—or if you wish, send us your engineering drawings.

> For example, one maker of eight types of machines cuts costs by using only three sizes of joints. This means smaller inventories, fewer parts to catalog and stock, and volume prices.

TWO—Save time at the start of new projects by sending us a "Spec Sheet" with your data. Our engineers will submit drawings and recommendations that may forestall problems later.

Blood Brothers builds more standard types and sizes of universal joints than any other manufacturer—and will gladly work with you to help cut costs.

Just write or call—and request your supply of handy blank "Spec Sheets" for use now or later.

ROCKWELL-STANDARD CORPORATION
(Formerly Rockwell Spring and Axle Company)

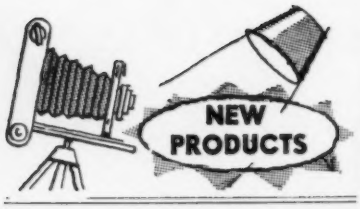
Blood Brothers Universal Joints

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS
AND DRIVE LINE
ASSEMBLIES

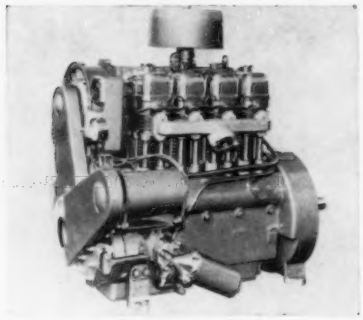
© 1958, Rockwell-Standard Corp.

(For more facts circle No. 75 on reply card)



British Diesel for American Market

Brush Aboe, Inc. has introduced to the American market a high-speed light-weight Petters diesel engine for small agricultural,

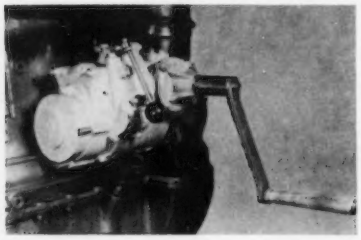


marine and industrial equipment. The new engines—designated the PC series—range in weight from 243 lb for the single cylinder PC-1 to 503 lb for the 4-cylinder PC-4, largest in the new series. Horsepower ratings range from 6.25 to 25. The 2-cylinder PC-2, weighing 329 lb is rated at 12.5 hp and the 3-cylinder PC-3, 18.75 hp. It weighs 439 lb. All models in the new series operate at a constant speed of 3,000 rpm.

(For more facts circle No. 13 on reply card)

Hand Starter for Diesels

Inertia Starter Developments Ltd. has developed a mechanical device for starting diesel engines by hand. The manufacturer



reports that the unit is adaptable to existing diesel engines without modification.

In operation the system reportedly builds up a store of kinetic energy which, at the appropriate moment, is transmitted to the flywheel of the engine.

(For more facts circle No. 14 on reply card)

Forage Box and Bunk Feeder

New Idea Farm Equipment Co. has introduced a new, 360 cu-ft, high-capacity forage box and bunk feeder. The versatile box unloads from the side into blowers, bunks and

elevators or from the rear into pit and bank silos, blowers and elevators. The unit can be mounted on wagon running gear or a truck bed.

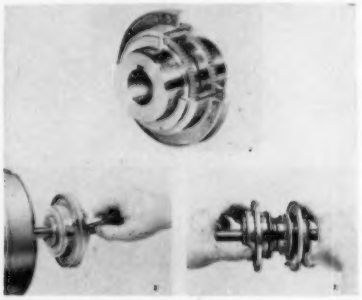
Feed supplements and preservatives added to the top of the load can be mixed during unloading by two large 6-bar cylinders. Maximum conveyor speed is 7 fpm. The 20-in. wide cross conveyor is made from 3-ply rough top belting. A 36-in. conveyor extension with rough top belting is available for feeding into high bunks.

For rear unloading the bed conveyor gear box, which is used for side unloading, can be mounted on the rear of the machine. Roller chains are used on all drives.

(For more facts circle No. 15 on reply card)

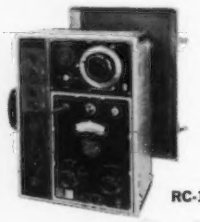
Offers New Flexible Coupling

Link-Belt Co. has announced a new low-cost geared flexible coupling for shaft diameters up to 1⅞ in. Called the type



MC, it is designed especially for use as a motor coupling — for transmitting electric motor power to pumps, generators, speed reducers, etc. Basic principles of operation are like those of a conventional geared

BN-2


RC-12C1P

RD-15

CONDUCTIVITY EQUIPMENT FOR TESTING SOIL

Measure moisture content and soluble salt or fertilizer content with easy-to-use Industrial Instruments Conductivity Bridges!

BOUYOUCOS TRANSISTORIZED MOISTURE METER . . . designed for simple, rapid field testing of available soil moisture. Connect meter to leads from buried soil blocks and read moisture content directly. Completely self-contained, uses 4 inexpensive penlight batteries lasting 2 years. Second meter scale calibrated in ohms measured resistance. BN-2 Meter complete with neck strap and batteries **$92.00**

Gypsum Soil Blocks—impregnated with plastic for extra-life. Stainless steel electrodes and 5 ft leads . . . . . CEL-WWD—each **$2.20**

MODEL RC-12C1P SOIL MOISTURE BRIDGE . . . high accuracy research instrument incorporating true Wheatstone Bridge circuit with 1000 cps bridge oscillator. Range 0.2 to 2,500,000 ohms with 1% accuracy except at extreme ends of scale. 84" effective scale length and built-in adjustable capacitance up to 21,000 mmf. Electron "eye" null indicator and earphones. Battery-operated and contained in portable carrying case **$250.00**

SOLU BRIDGE SOIL TESTER MODEL RD-15 . . . for laboratory testing of soil extract conductivity and particularly valuable for use by flower growers and in greenhouses. Simplest and easiest to use, the RD-15 is an AC Wheatstone Bridge, line operated, "eye" tube used for null indicator. Calibrated 10-1000 mhos x 10^{-5}. Manual temperature compensator 50-100°F. In gray wrinkle steel case, for 115V/50-60 cycle AC operation **$70.00**

Conductivity cell CEL-S2—sturdy molded polystyrene dip cell **$16.75**

For complete details on these and other conductivity soil testing instruments and accessories write to...

Industrial Instruments

89 Commerce Road — Cedar Grove — Essex County — New Jersey

(For more facts circle No. 78 on reply card)

coupling, i.e., externally geared hubs are mounted on the shafts and joined flexibly by an internally geared sleeve. Power transmitting parts are steel and fully machined.

The MC coupling sleeve is of one-piece design, and the coupling is enclosed in a two-piece metal cover, which is sealed to prevent loss of lubricant or entry of contaminants. A special feature of the coupling centers on the use of spiral camlocking fasteners which join the cover flanges. These fasteners are permanently assembled as part of the cover halves (there are no loose bolts and nuts) and require only a quarter turn for fastening or detaching. Illustration demonstrates how the three spiral cam-locking fasteners can be detached and the coupling opened.

(For more facts circle No. 16 on reply card)

New Utility Scraper

Seaman-Gunnison Corp. has introduced a new utility scraper with a scarifier-ripper built in as an integral part of the machine. The scarifier can be hydraulically lowered on the back haul to rip the soil for the loading runs and can be used as a rake for removing over-size rock from fill.

The self-loading scraper is powered by an International 650 diesel tractor modified

as an 88-hp, two-wheel prime mover. All steering and scraper controls are hydraulic. Five speeds range from 2.4 to 21 mph. Maximum cutting depth is 4 in. and spread is from 2 to 14 in. The scraper cuts a 7-ft width. Weight without load is approximately 16,000 lb. The unit can be obtained with a modified International W 450 diesel, providing 10 speeds forward from approximately 1.6 to 17 mph.

(For more facts circle No. 17 on reply card)

Push-Button SP Baler

New Holland Machine Co. has announced a new self-propelled push-button baler to be shown at fairs and special demonstrations

throughout the United States and Canada this year. Only a few of the new balers will be made this year but the company is considering expanded production for the 1959 haying season. Called the Haycruiser 178, the new baler is operated entirely from a control center on the baler. Seated or standing, the operator can change ground speed and feeding action by pushing a button. A button controls ground speed; a lever controls baling action. Variable drive on the transmission keeps the ground speed entirely independent of the baling operation. The unit is powered by a 51-hp engine and has a four-speed transmission.

(For more facts circle No. 18 on reply card)

(Continued on page 371)

STEEL CASTINGS* help build dependability into the modern cargo carrier . . .

..Specifically **UNITCASTINGS!**

Transporting America's products by truck-trailer is a gigantic, ever-increasing task—calling for dependable, rugged, long-lasting equipment. This is the reason many manufacturers of over-the-highway carriers specify *foundry engineered UNITCASTINGS* for many component parts.

High quality cast steel affords intricate, one-piece designs . . . offers uniformity and strength for longer life, less maintenance, and more dependable product service.

And . . . *foundry engineered UNITCASTINGS*, produced by superior methods, assure steel castings that are internally sound . . . surfaces that are clean and dimensionally accurate . . . and require minimum finishing. Lower *finished* cost is the *real* advantage of specifying UNITCASTINGS. Write for complete information today!

UNITCAST CORPORATION, Toledo 9, Ohio

In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

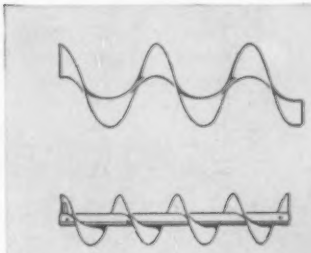
(For more facts circle No. 79 on reply card)

How LINK-BELT makes it easy to **work augers into your design**

INTERNATIONAL HARVESTER COMPANY employs Link-Belt screw conveyors throughout their No. 151 Harvester Thresher for gathering, conveying, elevating and distributing the harvest.

WHERE augers are a vital part of any equipment, here's the sure way to better equipment design. Link-Belt augers are available in a full range of diameters, gauges and pitches . . . in any suitable metal to meet your exacting requirements. They're simple and compact, accurately made to insure dependable operation.

For any design problem involving augers ask the Link-Belt office near you for engineering assistance.



SELECTED FLIGHTING for all your auger needs. Helicoid, sectional or a range of other types are available in the metal and finish best suited for your design.

SIMPLICITY OF CONSTRUCTION and sturdy design of Link-Belt augers provide dependable, efficient operation on your machine. One basic assembly — no other moving parts to break down.

YOUR CHOICE OF METALS answers your requirements for handling corrosive or abrasive materials. And Link-Belt uses only specially selected steels.

ENGINEERING SERVICES. Our auger specialists will help to analyze your special needs . . . integrate all elements of your design for overall system efficiency.

ALL COMPONENTS — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives—are available for every design.

LINK-BELT

FARM MACHINE AUGERS

Get in touch with the nearest Link-Belt office for your copy of Screw Conveyor Data Book 2289 . . . today.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,767

If you are not a member of the American Society of Agricultural Engineers and want (1) to subscribe* to AGRICULTURAL ENGINEERING or (2) to receive information about ASAE membership—or if you *are* a member of ASAE and want to propose the names of one or more prospective members — then simply fill out and mail the card at the right.

(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

CHECK

☐ I want to receive AGRICULTURAL ENGINEERING regularly. Enter my subscription for one year ($5.00 in USA; $5.50 in Canada; $6.00 elsewhere). Payment is enclosed.

☐ I would like information about membership in the American Society of Agricultural Engineers, including an application form. (I understand that a subscription to AGRICULTURAL ENGINEERING and a copy of AGRICULTURAL ENGINEERS YEARBOOK are included in the annual dues of ASAE members.)

☐ I am an ASAE member and suggest that membership information, including application form, be sent to the name and address below. I can supply names of _____ more prospective members. My name is _____

Name _____

Position or title _____

Address (☐ **Home or** ☐ **Business**) _____

City _____ **Zone** _____ **State** _____

Employed by _____

LET US KNOW YOUR WANTS

Do you want more data or other information on products or catalogs advertised or otherwise featured in this issue? Then fill out one of the two mailing cards at the right and drop it in the mail today.

Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

Use the card *below* for free data on new products and the card *above* for subscribing to AGRICULTURAL ENGINEERING, or for requesting information about membership in the ASAE.

Kindly have mailed to me, without obligation, more information about items in this issue indicated by the numbers circled below:

JUNE 1958

→ *Please print or type your name, etc., below* ←

Your name _____

Your position or title _____

Name of employer _____

Address of employer _____

City _____ Zone _____ State _____

New Products, New Catalogs, and Advertisements in AGRICULTURAL ENGINEERING

1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
10	20	30	40	50	60	70	80	90	100

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1 **St. Joseph, Mich.**

AGRICULTURAL ENGINEERING

P. O. Box 229

St. Joseph, Michigan

Reader Information Service

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1 St. Joseph, Mich.

American Society of Agricultural Engineers
P.O. Box 229
St. Joseph, Michigan

If you are not a member of the American Society of Agricultural Engineers and want (1) to subscribe* to AGRICULTURAL ENGINEERING or (2) to receive information about ASAE membership—or if you *are* a member of ASAE and want to propose the names of one or more prospective members — then simply fill out and mail the card at the left.

(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

Use the card *below* for free data on new products and the card *above* for subscribing to AGRICULTURAL ENGINEERING, or for requesting information about membership in the ASAE.

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1 St. Joseph, Mich.

AGRICULTURAL ENGINEERING
P. O. Box 229
St. Joseph, Michigan

Reader Information Service

LET US KNOW YOUR WANTS

Kindly have mailed to me, without obligation, more information about items in this issue indicated by the numbers circled below:

JUNE 1958

→ *Please print or type your name, etc., below* ←

Your name_____

Your position or title_____

Name of employer_____

Address of employer_____

City_____ Zone_____ State_____

New Products, New Catalogs, and Advertisements in AGRICULTURAL ENGINEERING

1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
10	20	30	40	50	60	70	80	90	100

Do you want more data or other information on products or catalogs advertised or otherwise featured in this issue? Then fill out one of the two mailing cards at the left and drop it in the mail today.

Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

TWO SOLUTIONS TO IRRIGATION PROBLEMS

"Water closet" principle with float-type shutoff

A cement cistern with 3,000 feet of pipe to carry water to the fields is the irrigation system setup on the 320-acre Orr farm near Eaton, Ohio. A float-type shutoff, like those found in plumbing systems, automatically shuts off the water when the tank is filled. Thus the right amount of water may be "measured" into the fields.

John Orr (right) explains system to Texaco Consignee Hubert Miller (left) and farm service man, Paul Myers. The Orrs have found that it pays to farm with Texaco products.

1,000 gallons a minute from 1,200-foot well

The irrigation system on the 2,000-acre Cecil Reagan farm near Knippa, Texas, consists of a well over 1,200 feet deep and a diesel engine operated pump, which delivers 1,000 gallons of water a minute into the irrigation ditches. In dry spells the pump is operated 24 hours a day. Texaco products keep engine and pump operating at top efficiency.

Texaco Consignee L. Collicoatte of Sabinal, Texas, gives dependable on-time deliveries of Texaco products at the Reagan farm, as and when they are needed.

LES GILMAN, successful dairy farmer of Medford, Oregon, agrees with Jack Rose, driver for Texaco Consignee Ken Teeter, that Texaco Marfak lubricant sticks to bearings, won't drip out, dry out, jar out, wash out or cake up.

GENE CORBIN of the Rainbow Lakes 4,000-acre cattle ranch, Dunnellan, Florida, talks Havoline Motor Oil with Texaco Consignee D. F. White. He agrees that Havoline wear-proofs tractor engines – cleans as it lubricates.

IN ALL 48 STATES – you'll find Texaco Dealers with top-octane Texaco Sky Chief Su-preme gasoline, supercharged with Petrox, for maximum power and famous Fire Chief gasoline at *regular* price. Havoline Motor Oil and Marfak lubricant.

On farm and highway it pays to use

TEXACO PRODUCTS

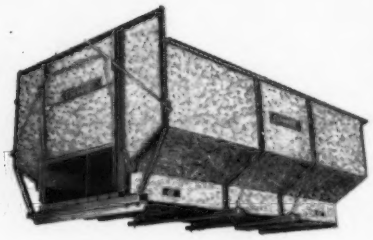
Texaco Products are also distributed in Canada, Latin America, and Africa.

TEXACO

THE TEXAS COMPANY

(For more facts circle No. 77 on reply card)

BIG!



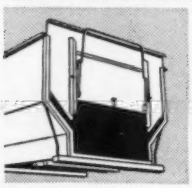
NEW!

ELECTRIC

125-bu. Flare box at low price!

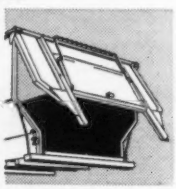
Choose either an easily removable *conventional* or *swinging* endgate. Heavy-gauge galvanized steel and reinforced contoured side-supports insure box rigidity, eliminate sagging or bulging with full loads. Complete with 2" deck, stake pockets, and anti-spreader chain. Backed by over 70 years' experience in the farm equipment field.

TWO OPTIONAL ENDGATES



MODEL 5126

New endgate with large sliding panel. Entire endgate lifts out by removing two rods.



MODEL 5125

Swinging endgate with large sliding panel and new positive locking device.

See complete ELECTRIC *line at your nearest dealer.*

ELECTRIC WHEEL CO.

2800 CEDAR, QUINCY, ILLINOIS

Division of the Firestone Tire & Rubber Company

(For more facts circle No. 72 on reply card)

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Mechanical Peanut Harvesting Practical in Virginia

Mechanical harvesting in Virginia is one step closer to being a standard practice with the availability of commercially manufactured two-row digger-shaker-windrowers. These machines, developed by Agricultural Engineering Research Division, ARS, USDA, and Virginia Polytechnic Institute in cooperation with a local manufacturer, are being used in conjunction with peanut shaker-windrowers, combines, and mechanical drying to reduce drastically the number of man-hours needed to harvest a crop.

Field tests at the Tidewater Research Station, Holland, Va., proved combining efficient, especially under favorable harvesting conditions.

Castor Bean Acreage Increases as Harvesters Are Built

Reports indicate that the acreage of castor beans grown in the United States is limited largely by the number of machines available for harvesting. In 1957, 15,800 acres were grown in California, Arizona, Texas, New Mexico, Oklahoma, and the Mississippi Delta area.

Practically all the irrigated acreage in California, Arizona, and Texas was harvested with 26 harvesters, built by three manufacturers who employed many components and features developed on the USDA castor harvester by L. G. Schoenleber in cooperation with the Oklahoma Agricultural Experiment Station. Several of the major components include: the huller-cleaner, vibrating row seal brushes, knockers, scalpers, elevators, and augers.

Afternoon Picked Cotton Grades Highest

Early-morning picked cotton and afternoon-picked cotton, stored in trailers for a period of time before ginning, and given equal drying in the gin, resulted in grades almost a full grade lower for morning-picked bales. Studies conducted by Agricultural Engineering Research Division, ARS, USDA, and Mississippi Experiment Station showed this grade loss resulted from loss of color while stored in trailers.

These tests, comparable to normal commercial operations, illustrate the importance of picking only when cotton is thoroughly dry to avoid grade loss because of delayed ginning.

Results of tests where picking was done throughout the day show that lint quality is not measurably affected by picking when seed-cotton contains excess moisture, provided it is carried directly to the gin and dried thoroughly in the gin.

Thompson Transfers

Harold J. Thompson, USDA agricultural engineer of the Livestock Engineering and Farm Structures staff, has transferred recently to the Department's ARS Administrative Services Division in Washington, D.C. Thompson, a native of Missouri and a graduate of Iowa State College, joined USDA in 1939, at Beltsville. He spent 4½ years in the Army Corps of Engineers, after which he worked at Columbia, Mo. He was mainly responsible for the construction of and the first years of operation of the psycho-energetic laboratory, as part of his long time experiments on the study of the effect of environment on farm animals.

New Leaflet Service

A new series of leaflets describing plans for farm buildings and structures for general distribution has been announced. These leaflets, mostly one page in length, are being prepared by the USDA Agricultural Engineering Research Division. The actual drawing plans for these buildings and structures will be available at agricultural engineering departments at Land Grant colleges.

New Poultry Building to Aid Research

Research to determine environmental factors affecting fertility in turkeys will be aided materially by a newly constructed poultry house now being fully equipped at USDA's Agricultural Research Center, Beltsville, Md. Designed by USDA engineers, the structure embodies facilities that will enable the poultry scientists to provide any "climate" required for turkeys under various experiments.

Positive means of controlling light, temperature and humidity have been installed in the experimental building. Three heat pumps will provide air-conditioning winter and summer. The building has no windows or other means of admitting daylight and is 20 ft wide by 60 ft long. It is constructed of corrugated galvanized steel, insulated on the inside. It is equipped with electrostatic type air filters capable of taking 90 to 95 percent of the dust particles out of the air.

In addition to its usefulness in continuing studies of the effect of light on male turkey fertility, the new building will serve another important purpose. It is expected to show how best to use its mechanical and electrical equipment to provide the exact "weather" conditions needed for different experiments. The poultry industry in particular and the livestock industry in general are becoming aware of the potential usefulness of controlling the environment for more efficient production. The experiments conducted in this building may supply clues for design of poultry and livestock shelters of the future.

. . . News

(Continued from page 356)

VPI Engineering Conference

Wayne H. Worthington, director of engineering research, John Deere Research and Engineering Center, was the speaker for the Agricultural Engineering Symposium held in conjunction with the Engineering Conference at Virginia Polytechnic Institute, April 24 to 26. Mr. Worthington discussed the field of power farming, emphasizing points of special interest to agricultural engineering students. Following his discussion, Mr. Worthington answered questions from the group.

For the second year, the VPI Student Branch of ASAE, submitted the winning theme for the conference—New Horizons Through Engineering.

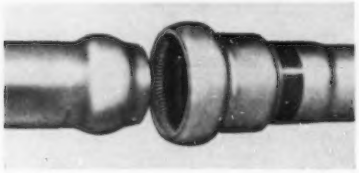
The Annual Engineering Conference is sponsored by the Association for the Advancement of Engineering, a student group made up of representatives from each of the engineering curriculum clubs. This is the ninth consecutive year that the conference has been held.

. . . New Products

(Continued from page 365)

Aluminum Suction Equipment

W. R. Ames Co. has introduced new aluminum suction equipment which can be adapted to many agricultural uses by em-



ploying available fittings: wire-mesh suction screen, foot valve to keep pump primed when not in operation, suction gage, elbows, tees, plugs, and a broad selection of in-line valves

A V-type suction gasket at each coupling junction reportedly allows an 11-deg. off-center movement in any direction without breaking the suction seal. Couplers have no hooks or latches and are self-sealing. The suction line, from source to pump, can be as long as is required — made up by simply coupling together the 5-ft or longer lengths of 3 to 8-in. diam. portable aluminum pipe with steel coupler ends.

(For more facts circle No. 19 on reply card)

Amphibious Trencher

Cleveland Trencher Co. has announced that adaptations of their trencher have made it possible to dig a pipeline from Deep Lake

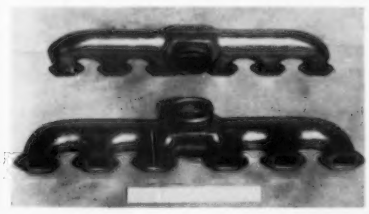
to Lake Charles in the marshlands of Cameron Parish, La.

The amphibious trencher was equipped with special pontoons and hooked up with a "Marsh Buggy" to aid forward movement. This combination reportedly did a good job of digging its way through the swamplands, despite the fact that shallow water covered much of the right-of-way for the 6-in. connecting line.

(For more facts circle No. 20 on reply card)

Offers Stamped Manifolds

Transue & Williams Steel Forging Corp., Stamping Division, is now producing manifolds by the stamping process. The 33-in.



intake manifold (shown) consists of 18-gage and 5/16-in. plate stampings, joined by welding. All parts are made, assembled, and welded.

(For more facts circle No. 21 on reply card)

Makes Round Bales Without Stopping

Allis-Chalmers Mfg. Co. has developed a new continuous flow non-stop Roto-Baler, a companion to the standard model which first introduced the round bale in contrast to the square bale. The roll-up compression principle of the new baler is the same as the standard model except that the baling operation is continuous. Dimension of the bale and the method of forming it are the same.

Continuous forward motion is made possible in the new model by a simple device that automatically bypasses the incoming material over a longer route while the bale in the machine is being wrapped and discharged, after which the cycle is repeated.

The operation is entirely automatic. In the standard model the forward travel is halted when the bale has reached its predetermined diameter, and remains so while the bale is being automatically wrapped with twine and discharged from the machine.

(For more facts circle No. 22 on reply card)

Consider: "WISCONSIN"

SELLING POWER

as well as DRIVING POWER!

THE ENGINE SHOULD PROVIDE BOTH!

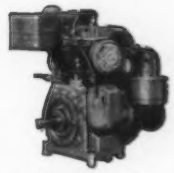
The reputability and acceptance of the equipment *you design* and *your company builds,* logically hinges upon superior performance characteristics, operating economy, low cost maintenance, long life and the ready availability of competent servicing if and when needed. All this adds up to *Selling Power!* The better the equipment, the easier it is to sell, of course.

And when it comes to original equipment *Driving Power,* each of the foregoing factors applies to Wisconsin Heavy-Duty Air-Cooled Engines. Known and accepted throughout the entire world as the top standard of engine value, the name "WISCONSIN" adds prestige and *buyers' confidence* to your own equipment. This, too, is SELLING POWER.

Wisconsin heavy-duty design and construction in all details; high torque load-holding Lugging Power and efficient AIR-COOLING at all temperatures from sub-zero to 140° F. are some of the practical considerations worth remembering.

Add WISCONSIN *Driving Power* and *Selling Power* to your equipment . . . for greater sales opportunities in a "hard sell" market and better satisfaction to the users of your equipment. Wisconsin Engines are supplied in a full range of sizes, 3 to 56 hp., in 4-cycle single cylinder, 2- and V-type 4-cylinder Models. *All models can be equipped with electric starting.* World-wide service available through more than 2,000 authorized service stations.

Complete your engine data file with a copy of Engine Bulletin S-223. Write for it today.



4-cycle single cyl. 3 to 12½ hp.

2-cylinder models, 10 to 18 hp.

V-type 4-cylinder, 15 to 56 hp.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

(For more facts circle No. 80 on reply card)

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

POSITIONS OPEN — 1957 — DECEMBER — O-385-763, 386-764, 387-765, 412-766, 370-767. 1958 — JANUARY — O-478-769. FEBRUARY — O-12-801, 48-803. MARCH — O-37-804, 72-805, 78-806, 83-807. APRIL — O-70-808, 97-809, 122-811, 121-812, 120-813. MAY — O-129-814, 147-815, 69-817, 132-818, 132-819, 154-820, 158-821, 159-822.

POSITIONS WANTED — 1957 — DECEMBER — W-371-52, 378-53, 394-54, 405-55, 409-56, 415-57. 1958 — JANUARY — 0-447-58, 410-59, 381-60, 466-61, 484-62, 485-63, 3-1, 4-2. FEBRUARY — W-31-5, 33-6. MARCH — W-36-8, 62-9, 46-10, 80-12. APRIL — W-47-13, 77-14, 98-15, 102-16, 107-17, 94-18, 106-19. MAY — W-25-20, 127-21, 128-22, 143-23, 151-24.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER, instructor and assistant agricultural engineer rating, for teaching farm shop and research in field of soil and water with emphasis on irrigation, at southern land grant university. BSAE. MS preferred. Recent graduate considered. Age 21-45. Interest in handling students, ability to meet people, inquiring mind, and ability to work in cooperation with others. Excellent opportunity for advancement. Appointment on 12-mo basis. Good insurance and retirement plan. Can take 4 hours graduate work per semester. Salary $5,000-6,000. O-189-823

AGRICULTURAL ENGINEER, assistant professor, for research in machinery and extension in materials handling equipment, at eastern land grant university. MSAE. Farm background and some experience in research or extension. Major interest in machinery and farmstead materials handling equipment. Time about equal on research and extension. Excellent facilities and opportunities for research. Extension program in specific technical field. Salary $6210-6450. O-194-824

AGRICULTURAL ENGINEER, instructor, for teaching and research in hydrology, ground water hydraulics, and possibly structures, at a state university in the Southwest. MSAE or MSCE. Some practical experience in engineering and agriculture. Usual personal qualifications for college teaching and research. Normal opportunity for advancement. Salary open. O-199-825

AGRICULTURAL ENGINEER, instructor for courses in irrigation, hydraulics, hydrology, surveying, and conservation engineering at a western state technical school. Advisory work with students majoring in agricultural engineering. Cooperate with other departments in implementing a sound program of irrigation and soil conservation for the college farm. Age 28-45. MS or equivalent in agricultural or irrigation engineering. Farm background desirable. College teaching experience, or engineering with irrigation district or soil and water conservation agency. Ability and interest in teaching. Able to cooperate. Initiative and enthusiasm to develop an outstanding program. Position open September 15. Salary $5496-8520. O-200-826

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for development, teaching, sales or management in power and machinery, rural electric or product processing field with industry or public service. Any location. Willing to travel. Married. Age 35. No disability. MSAE, Michigan State University. College teaching experience, 2 years. Sales and management with large manufacturer of wheel and track-type tractors. World War II service in European theatre of operations. Available on reasonable notice. Salary open. W-164-25

AGRICULTURAL ENGINEER for extension, teaching, research, sales, service, writing or management in farm structures or rural electric field, with industry or public service, anywhere in USA. Willing to travel. Married. Age 30. Wear glasses. BSAE, 1950, University of Missouri. Farm background. Product research engineer with metal building manufacturer 3½ years, including technical assistance to sales and liaison with agricultural schools. Engineering product sales training and sales over 3 years. Available on 2 weeks notice. Salary $750 per mo. W-175-26

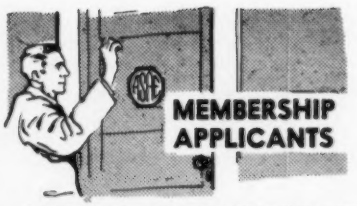
AGRICULTURAL ENGINEER for extension, sales, or service with rural electric or soil and water field, with industry or public service, anywhere in USA. Will travel. Single. Age 34. No disability. BSAE, 1952, University of Tennessee. Farm background. Construction of electrical transmission and distribution lines, 2 years. Designing, selling, and installing irrigation equipment and domestic water systems, 5 years. Some contracting, mostly on residential wiring and plumbing. Available June 15. Salary open. W-188-27

AGRICULTURAL ENGINEER for research in soil and water, product processing, or farm structures, with industry or public service in Gulf states or Southwest. Married. Age 43. No disability. BSAE, 1953, University of Arkansas. Land drainage and water resources work with Louisiana Department of Public Works, 3 years. Farm management experience, 4 years. Available on one month notice. Salary open. W-79-28

AGRICULTURAL ENGINEER for extension, teaching, research, sales or service in power and machinery field with industry, in Pakistan. Married. Age 34. No disability. BSAE, 1948, Allahabad Agricultural Institute. MSA, 1958, University of Toronto. Teaching and practice in agricultural engineering 6 years, under government of East Pakistan. Available on short notice. Salary $500 (USA funds). W-192-29

AGRICULTURAL ENGINEER for management or development work in power and machinery with manufacturer or processor, preferably in Southeast. Limited travel. Single. Age 29. No disability. BSAE, 1955, Alabama Polytechnic Institute. Experience since graduation with SCS, USDA, as planning engineer and area engineer. Military service in Marine Corps and Army. Available on two weeks notice. Salary $450 per mo. W-172-30

AGRICULTURAL ENGINEER for design, development, or research in the field of power and machinery, with manufacturer, any location, Midwest preferred. Single. Age 23. No disability. BSAE, 1957, Michigan State University. Summer work in physical test laboratory. Available on reasonable notice. Salary $450-500 per mo. W-205-31



The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Barrett, Monroe C. — Test engr., International Harvester Co. (Mail) 1547 Frayser Blvd., Memphis 7, Tenn.

Beyer, Irwin R. — Product designer, Larson Machine Co. (Mail) 537 Nelson Ave., Morton, Ill.

Bowen, David K.—Work unit conservationist, (SCS) USDA (Mail) 911 W. Ford Ave., Osceola, Ark.

Broadway, Ollie A., Jr.—Asst. mgr., Punta Alegre Suger Sales Co. (Mail) Central Macareno, Province of Camaguey, Cuba

Burris, Melvin — Agr. engr. (SCS) USDA, Box 271, Stillwater, Okla.

Davis, Fox, Jr. — Area engr., (SCS) USDA (Mail) P.O. Box 151, Evergreen, Ala.

Duffin, Robert B. — Ext. irrigation spec., Agricultural Extension Service, Oklahoma State Univ., Stillwater, Okla.

Forsberg, Carl M. — Irrigation spec., International Cooperation Administration. (Mail) Commander Apts. 414, 1225 13th St. N.W., Washington 5, D. C.

Greiner, James G. — Eng. trainee, New Holland Machine Co., Div. of Sperry Rand Corp. (Mail) 2469 New Holland Pike, Lancaster, Pa.

Hall, Charles D. — Field engr., Gates Rubber Co. (Mail) Box 206, Davenport, Iowa

Higginbotham, James A., Jr.—Service mgr., Ohio Tractor & Implement Co. (Mail) 229 W. 8th Ave., Columbus 1, Ohio

Hutchings, Herbert C., Jr. — Farm mgr., Wirthmore Research Farm, So. Main St., Berkley, Mass.

Iravani, Amir—Agr. eng. dept., Ave. Saadi Teheran—Iran. (Mail) c/o Mr. A. E. Duke, FAS, USDA, Washington 25, D. C.

Kishida, Yoshikuni — Pres. publisher, Shinnorin Co., 7-2 Kanda Nishikicho, Tokyo, Japan

Klassen, John B., Jr. — Engr., Bendix Aviation Corp., Lakeshore Div., St. Joseph, Mich.

(Continued on page 373)

Closed Die Forged
AMMONIA APPLICATOR
BLADE

ANOTHER QUALITY PRODUCT BY
PITTSBURGH FORGINGS CO.
FARM TOOLS DIVISION
60 THORN STREET
CORAOPOLIS, PENNA.

PART NAME: Anhydrous Ammonia Applicator Blade
USED ON: Anhydrous Ammonia Applicator
WEIGHT: 4.5#
MATERIAL: AISI 1020
HEAT TREATMENT: Normalize, Quench and Draw, Case Harden to 1/16" Deep

Why A Forging . . . .

This applicator blade is essentially a ground engaging tool . . . one that must work deep in the soil. It must be strong enough to withstand countless severe shocks and constant abrasion. Yet, the blade must be thin enough to assure a light draft. Only CLOSED DIE FORGING can meet these requirements BETTER than any other process. At each stage of production . . . forging, trimming, punching, padding, initial cleaning, case application, normalizing, straightening and gauging, quenching and drawing and final cleaning . . . balanced toughness and strength are built into the blade. When you have a problem part, let the EXPERIENCED agricultural forgings engineers at Pittsburgh Forgings Company help you.

. . . Membership Applicants

(Continued from page 372)

Lester, Raymond L. — State conservation engr., (SCS) USDA. (Mail) 561 U. S. Courthouse, Nashville 3, Tenn.

McClelland, John H.—Sr. res. officer, Commonwealth Scientific & Industrial Research Orgn., Graham Rd., Highett, Victoria, Australia

Moffett, Tommy C. — District rural serv. engr., Alabama Power Co., 1201 Noble St., Anniston, Ala.

Reidelbach, John A., Jr. — Structural engr., Timber Eng. Co. (Mail) 2110 S. 27th St., Arlington, Va.

Salzer, Herbert C. — Sales mgr., Motor Wheel Corp., Lansing 3, Mich.

Scott, Paul M. Jr. — Asst. territory mgr., John Deere Plow Co. (Mail) Box 185, Ronceverte, W. Va.

Seitzinger, John G. — Pres., Oaks Irrigation Equipment Co., Inc. (Mail) P.O. Box 1075, Pharr, Tex.

Siy, Felipe Lian-Fuy—Engr., Allis-Chalmers Mfg. Co. (Mail) 200 S. Willis, Independence, Mo.

Trabbic, Gerald W. — Grad. asst. in agr. eng., Michigan State Univ., East Lansing, Mich.

Tyler, William R. — Dev. engr., Aluminum Co. of America, P.O. Box 1012, New Kensington, Pa.

Willoughby, Grady L. — Work unit engr., (SCS) USDA. (Mail) P.O. Box 892, Quincy, Calif.

Wood, Arthur F. — Agr. engr., (SCS) USDA. (Mail) R.R. 1, Oakland Dr., Jensen Beach, Fla.

Transfer of Membership

Cromwell, Charles F., Jr. — Asst. prof. in agr. eng., Univ. of Missouri, Columbia, Mo. (Associate Member to Member)

Harris, Kenneth A. — Agr. engr. (SCS) USDA. (Mail) P.O. Box 161, Stuart, Fla. (Associate Member to Member)

Jensen, Marvin E. — Agr. engr. (ARS, SWCRD) USDA, Southwestern Great Plains Field Sta. (Mail) 2901 W. Haven Dr., Amarillo, Tex. (Associate Member to Member)

McIntyre, Ronald R. — Asst. chief engr., Maritime Marshland Rehabilitation Administration. (Mail) Box 248, Amherst, Nova Scotia, Canada (Associate Member to Member)

Sauer, Gilbert F. — Product engr., Armco Drainage and Metal Products. (Mail) 118 Bellemonte St., Middletown, Ohio. (Associate Member to Member)

Thede, V. W. — Sales engr., French & Hecht Div., Kelsey-Hayes Co., Davenport, Iowa. (Affiliate Member to Member)

Student Transfers

Burrows, Marshall C.—Research asst., Univ. of Wisconsin. (Mail) 214 N. Murray St., Madison 5, Wis.

Carver, Ronald C. — Engr. trainee, John Deere Waterloo Tractor Works. (Mail) 1041½ W. 6th St., Waterloo, Iowa

Chalk, Julian L. — Student, Michigan State Univ. (Mail) 230 Big Beaver Rd., Birmingham, Mich.

Chamberlain, Neal C. — John Deere Des Moines Works, Des Moines, Iowa

Pigg, Delbert L.—Graduate asst., agr. eng. dept., Univ. of Illinois, Urbana, Ill.

Sampson, Olin J. — Oliver Corp. (Mail) 627 7th St., Ames, Iowa

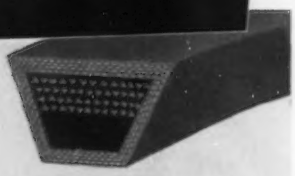
Schoff, Paul E. — Student, Univ. of Wisconsin. (Mail) 925 Emerald St., Madison 5, Wis.

Smith, Dorland W. — Power use advisor, Menard Electric Corp. (Mail) R.R. 1, Topeka, Ill.

A Browning GRIPBELT FOR EVERY PURPOSE!

DOUBLE-V GRIPBELT

For multiple shaft drives. Driven shafts may operate in the same or opposite directions.



GRIPBELT, SUPER GRIPBELT

The high-quality all-purpose belts proved by years of satisfactory service in all types of drives.

GRIPLINK

This unique belt assembles to any length needed. Ideal where obstructions hinder belt replacement.

POLY-V® BELT

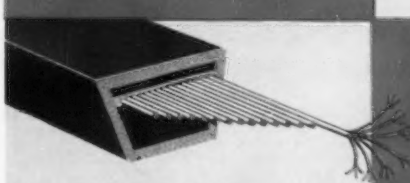
New multiple V-belt in single unit. Delivers more horsepower, cuts space requirements, eliminates matching problem.

FHP BELT

The perfect low-cost belt for all light-duty drives. Smooth, vibrationless power, longer life.

GRIPROLL

For special applications where endless belt cannot be used. Cuts to any length, splices readily.



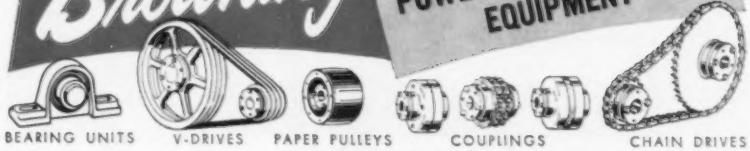
STEEL CABLE GRIPBELT

Transmits heavier loads with smaller sheaves or fewer belts. Negligible stretch, longer life, greater economy.

Choose from these dependable Browning belts for every farm equipment need. With Browning's wide range of single and multiple groove sheaves, they form the most complete V-drive line available. Write today for details and your copy of illustrated catalog GC101.

Browning Manufacturing Company, Maysville, Kentucky.

Browning POWER TRANSMISSION EQUIPMENT



BEARING UNITS V-DRIVES PAPER PULLEYS COUPLINGS CHAIN DRIVES

(For more facts circle No. 53 on reply card)

in the best circles . . .

Locke Steel detachable sprocket chain provides dependable power transmission and material conveying on the finest farm machinery

LOCKE STEEL DETACHABLE SPROCKET CHAIN

THE LOCKE STEEL CHAIN COMPANY • HUNTINGTON, IND.

(For more facts circle No. 81 on reply card)

NEW FOR SPRAY BOOMS

To simplify installation and operation . . . to improve performance: (1) Spraying Systems Lightweight Double Swivel Connectors for drop pipes in row crop spraying, adjustable in 360° arc—write for Bulletin 90 . . . and (2 and 3) TeeJet Split-Eyelet Spray Nozzles and Connectors with twin bolt steel clamps and separate bodies in choice of brass, stainless steel and aluminum—write for Bulletin 89. All new in 1958.

SPRAYING SYSTEMS CO., 3226 Randolph St. • Bellwood, Ill.

by the producers of TeeJet SPRAY NOZZLES and TeeJet interchangeable orifice tips.

(For more facts circle No. 83 on reply card)

THE FIRST AUTOMATION IN GRAIN STORAGE

AUTO HUMIDITY CONTROL
DRY-O-MATION
NATURAL DRYING

DRY-O-MATION is DRYING IN STORAGE! NO HANDLING—A Great Saving for the Farmer!

Pat. Applied For

With the DRY-O-MATION System of grain conditioning the supplemental heater attached to the fan automatically and instantaneously supplies heat to **maintain natural drying conditions that are always favorable.**

DRY-O-MATION assures uniform conditioning of **every** layer of grain in **every** part of the bin. Less shrinkage; no over-drying. Field-tested DRY-O-MATION makes the step from field to storage bin one continuous operation that saves time and money. It produces clean, premium quality grain every time. We cordially invite you to become fully acquainted with the simple, practical and low costing advantages of DRY-O-MATION. **Write us today for your free copy of the DRY-O-MATION Story.**

FARM FANS / DIVISION OF EWING FOUNDRY, INC. 424 S. Pennsylvania St., Indianapolis 25, Ind.

(For more facts circle No. 82 on reply card)

A Handsome, Permanent Binder for AGRICULTURAL ENGINEERING

One copy **$2.80**

Two or more $2.40 each
Postpaid in U. S. A.
Foreign postage extra

THE ONLY binder that opens flat as a bound book! Made of durable, green imitation leather, nicely stamped on backbone with the name of journal and year and volume number, it will preserve your journals permanently. Each cover holds 12 issues (one volume). Do your own binding at home in a few minutes. Instructions easy to follow. Mail coupon for full information, or binder on 10-day free trial.

---------- MAIL COUPON TODAY ----------

THE SUCKERT LOOSE-LEAF COVER CO.
11911 Grand River Ave., Detroit 4, Mich.

Mail postpaid_____ binders for Agricultural Engineering for years_____
Will remit in 10 days or return binders.

Name_____

Address_____

City_____ State_____

(Left) Officers for Michigan Section were installed during the spring meeting and ladies night at the Howell Boy Scout Camp, Brighton, on April 18. *(Left to right)* W. F. Buchele, vice-chairman; C. B. Richey, chairman; Earl D. Anderson, president of ASAE; D. E. Wiant, vice-chairman; B. G. Elliott, vice-chairman; and F. H. Buelow, secretary-treasurer • *(Right)* New officers for the Mid-Central Section are *(left to right, standing)* G. L. Kline, secretary-treasurer; C. L. Day, chairman; K. L. Von Bargen, nominating committee chairman; *(seated)* E. A. Olson, vice-chairman; D. R. Hunt, vice-chairman. J. D. Rector, vice-chairman, was not present

. . . With ASAE Sections

(Continued from page 362)

Charles Hanson, Deere and Co., in which he placed emphasis on the slogan: "Work smarter, not harder — it's easier."

Earl Anderson, Stran-Steel Corp. and ASAE president, stimulated new interest in farm materials handling in an address given during the Annual Dinner in which he reviewed improved quality control during on-the-farm storage and compared the amount of time saved in a working day for a dairy farmer who took advantage of the labor-saving materials handling program and the farmer who employed regular farm procedures without application of improved methods. The new officers elected were: Bruce A. Genzel, Chain Belt Co., chairman; John W. Ackley, John Deere Planter Works, and Bruce C. Arnold, J. I. Case Co., vice-chairmen; Robert G. Morgan, Timken Roller Bearing Co., secretary, and C. H. Shriver, Deere & Co., treasurer.

As part of a demonstration of long distance dialing planned for the Florida group by engineers of the Bell Telephone Co., President Earl Anderson gave a 15-minute telephone address to the Florida Section members during their Annual Meeting also held on April 26.

Alabama Section

Opening activities of the Alabama Section held April 17 and 18 at Montgomery included tours of the Hazel Atlas Glass Co., the Alaga Syrup Co., and W. W. Pickle Co.

Papers presented during the afternoon session stressed economic and engineering aspects of supplying electricity to a rural area, grounding and lightning protection of secondary services and related equipment, controls used in farm application, and environmental conditions needed for comfort in homes.

Judge J. Ed Livingston, chief justice, Alabama Supreme Court, addressed the guests who were present at the banquet Thursday evening.

Papers presented Friday morning were on water supplies and agriculture, furrow irrigation, planning and design of the Georgia State Farmer's Produce Market, agricultural aspects of developing a farm market, two-wheel vs. four wheel drive for tractors, and soil compaction by traffic.

The new officers include: chairman, A. W. Cooper, director, Tillage Machinery Laboratory; vice-chairman, H. N. McGough, engineer, W. F. Covington Planter Co., Inc., and secretary-treasurer, Walter Grub, associate engineer, Alabama Polytechnic Institute.

(Above) New officers for the Florida Section *(left to right)* C. W. Davis, 3rd vice-chairman; S. E. Dowling, secretary; D. S. Harrison, chairman; H. S. Nelson, treasurer; R. C. Lambert, past-chairman; D. E. Adams, 1st vice-chairman; and M. H. Byrom, 2nd vice-chairman

(Right) Bruce A. Genzel, Chain Belt Co., was elected chairman of the Quad City Section during a meeting held April 25 in Clinton, Iowa. New Section officers are *(left to right)* J. O. Utterback, chairman of nominating committee; Bruce C. Arnold, vice-chairman; B. A. Genzel, chairman; John W. Ackley, vice-chairman; R. G. Morgan, secretary; and L. J. Corkery, member of nominating committee

Index to Advertisers

Acme Chain Corp. 359
Aetna Ball & Roller Bearing Co. 317
Armco Steel Corp. 323
Automotive Gear Div., Eaton Mfg. Co. 320
Bearings Co. of America Div., Federal-Mogul-Bower Bearings, Inc. 327
Bendix Aviation Corp., Bendix Products Div. 333
Bendix Aviation Corp., Lakeshore Div. 324
Blood Bros. Universal Joint Div., Rockwell-Standard Corp. 363
Browning Mfg. Company 373
Caterpillar Tractor Co. 319
Electric Wheel Co., Div. of the Firestone Tire & Rubber Co. 370
Fafnir Bearing Company 321
Farm Fans, Div. of Ewing Foundry, Inc. 374
Industrial Instruments, Inc. 364
Ingersoll Products Div., Borg-Warner Corp. 330
International Harvester Co. 357
Kohler Company 332
Link-Belt Company ..... 3rd Cover, 366
Locke Steel Chain Co. 374
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 329
New Departure, Div., General Motors Corp. ..... 2nd Cover
The Ohio Rubber Co. 328
The Perfect Circle Corp. 334
Pittsburgh Forgings Co. 372
C. A. Roberts Co. 376
Rockford Clutch Div., Borg-Warner Corp. 358
Russell, Burdsall & Ward Bolt & Nut Co. 331
Spraying Systems Company 374
The Texas Company 369
Timken-Detroit Transmission & Axle Div., Rockwell-Standard Corp. 322
Timken Roller Bearing Co. ..... 4th Cover
Unitcast Corp. 365
John Wiley & Sons, Inc. 361
Wisconsin Motor Corp. 371

ADVERTISING REPRESENTATIVES

New York 17 — BILLINGSLEA AND FICKE, 420 Lexington Ave. LExington 2-3667

Chicago 2—DWIGHT EARLY AND SONS, 100 N. La Salle St. CEntral 6-2184

San Francisco 5 — McDONALD-THOMPSON, 625 Market St. YUkon 6-0647

Los Angeles 5 — McDONALD-THOMPSON, 3727 W. Sixth St. DUnkirk 7-5391

Seattle 4 — McDONALD-THOMPSON, 1008 Western Ave. MA. 3-3766

Portland 1—McDONALD-THOMPSON, 912 S. W. Market St. CApital 2-5146

Denver 2—McDONALD-THOMPSON, Colorado National Bank Bldg. KEystone 4-4669

Houston 6—McDONALD-THOMPSON, 3217 Montrose Blvd. JA. 9-6711

Tulsa 4 — McDONALD-THOMPSON, 2010 South Utica. RIverside 3-1981

Advertising Manager: RAYMOND OLNEY, 420 Main St., St. Joseph, Mich. YUkon 3-2700

Write for our latest stock list.

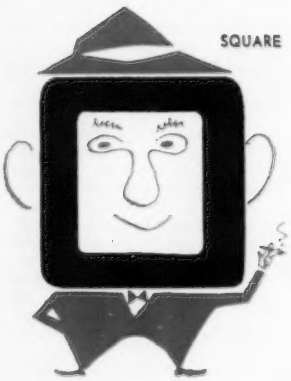
all shapes & sizes..

C. A. Roberts Co. carries more than 2,000 different size and shape items of mechanical tubing in stock.

Six conveniently located warehouses, serving nineteen mid-western states, allow C. A. Roberts to place incoming orders to the best advantage for customers. C. A. Roberts carries: • **Shelby Seamless • Cold Drawn Butt Welded • Stainless Tube, Pipe and Fittings • Welded • P.V.C.** (pipe and fittings).

Sizes are available from .008 through 50" OD, in rounds, squares, rectangles and special shapes.

C. A. Roberts Co. also makes Direct Mill Shipments.



C. A. ROBERTS CO.
Steel Tube Specialists
2401 Twenty-fifth Street, Franklin Park, Ill. • GLadstone 5-6400

The good name of your machine is LINK-BELT's first consideration . . . TRADE MARK . . . and quality should be your first consideration in the chain you buy

Choose LINK-BELT chain

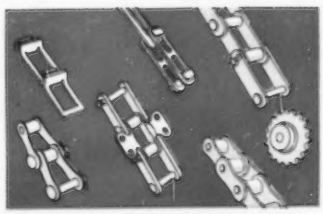
It's the efficiency-equal of your equipment!

Here's how LINK-BELT tailors drive and conveyor chains for the stresses they'll meet on your equipment

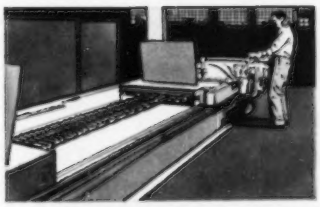
LINK-BELT chain designs are based on needs determined in field tests under actual working conditions. And by combining these results with modern laboratory controls and facilities of the world's largest chain plant, Link-Belt assures you of uniform quality chain for long drive and conveyor life. In addition, Link-Belt's broad line permits unbiased recommendations. Specific horsepower, loading and speed requirements of your equipment can all be satisfied.

Let these broad facilities and experience help protect the good name of your machine. For information, call the chain specialist in your nearby Link-Belt office.

ALLIS-CHALMERS MODEL 90 ALL-CROP HARVESTER employs Link-Belt double pitch "AG" roller chain, precision steel roller chain, and steel detachable chain—each chosen for its ability to satisfy specific operating conditions.



COMPLETE LINE of agricultural chains, sprocket wheels and attachments permits cost-saving specialization—offers right chain for all conveyor and drive needs.



ACCURATE MANUFACTURE and continuous inspection with specialized machines allow mass-production economies. Extensive facilities provide ample capacity to meet your production schedule.

LABORATORY CONTROL assures you that each chain meets rigid uniformity specifications. Our modern laboratory continuously explores new refinements to increase chain life.

LINK-BELT

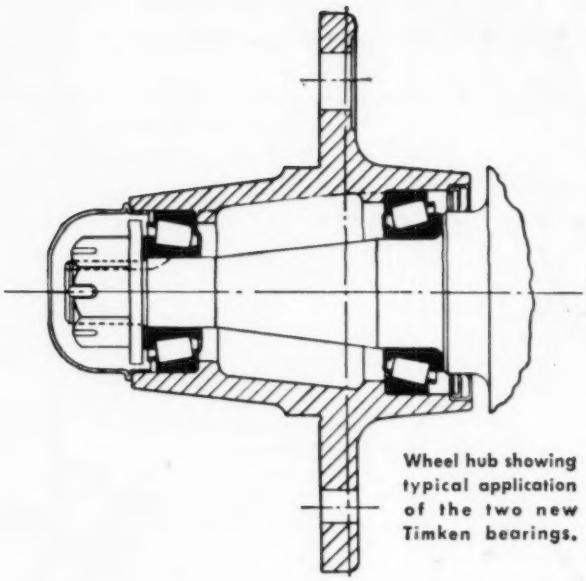
CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,589

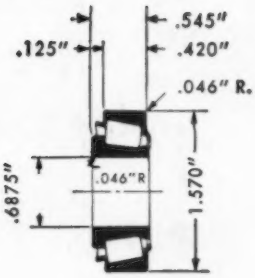
(For more facts circle No. 57 on reply card)

Two new TIMKEN® bearings open new design opportunities

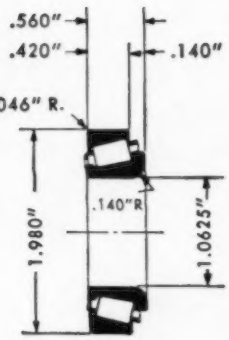
Bore sizes 1.0625" and .6875" offer high capacity in less space --opportunity to save on related parts



Wheel hub showing typical application of the two new Timken bearings.



LM 11749-LM 11710



L 44649-L 44610

WITH the two new small size Timken® bearings shown above, designers of farm implements can now get the advantages of roller bearings where they couldn't be used before. The small bearings pack high capacity in little space and they're lower in cost. They permit more compact designs, keeping related parts smaller—provide additional savings in hub materials, seals, nuts and dust caps, etc.

The inner bearing weighs about four oz. (.256 lb.). The outer bearing weighs less than three oz. (.181 lb.). They're the most economical single row Timken bearings ever produced in these bore sizes. Developed originally for use in small economical automobiles, they can be used wherever there is a need for an economical bearing in this size range ($1\frac{1}{16}$" and $1\frac{1}{16}$" bore). Diagram above at left shows them in a typical layout of a wheel hub for a light economy car. Diagram above at right shows principal dimensions.

Timken tapered roller bearings are geometrically designed and precision-made to roll true. Their taper lets them take *both* radial and thrust loads in any combination. With Timken bearings, agricultural engineers have money-saving answers to design problems involving 1) loads, 2) dirt, 3) ease of operation.

Field Engineering Service. Our Sales Engineers will gladly give you complete data on the new bearings, help you design them into your implements. Call or write: The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭
BEARING TAKES RADIAL ↓ AND THRUST →○← LOADS OR ANY COMBINATION ✳

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

(For more facts circle No. 58 on reply card)